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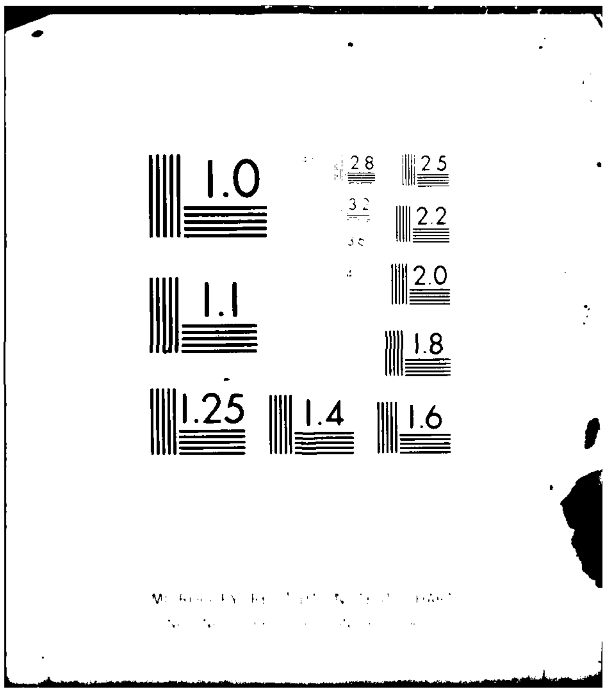
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SCHOOL OF ENGINEERING
AND APPLIED SCIENCE

USERS MANUAL
FOR THE
DYNAMIC STUDENT FLOW MODEL

by

William E. Caves
Dicky Wieland
W. L. Wilkinson

Serial T-447
31 July 1981

The George Washington University
School of Engineering and Applied Science
Institute for Management Science and Engineering

Program in Logistics

Contract N00014-80-C-0169
Project NR 347 059
Office of Naval Research

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER T-447	2. GOVT ACCESSION NO. AD-A110345	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) USERS MANUAL FOR THE DYNAMIC STUDENT FLOW MODEL		5. TYPE OF REPORT & PERIOD COVERED SCIENTIFIC
		6. PERFORMING ORG. REPORT NUMBER T-447
7. AUTHOR(s) WILLIAM E. CAVES, DICKY WIELAND, W. L. WILKINSON		8. CONTRACT OR GRANT NUMBER(s) N00014-80-C-0169
9. PERFORMING ORGANIZATION NAME AND ADDRESS THE GEORGE WASHINGTON UNIVERSITY, PROGRAM IN LOGISTICS, WASHINGTON, DC 20052		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS OFFICE OF NAVAL RESEARCH, CODE 434, ARLINGTON, VA 22217		12. REPORT DATE 31 July 1981
		13. NUMBER OF PAGES 144
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVED FOR PUBLIC SALE AND RELEASE; DISTRIBUTION UNLIMITED.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

NETWORK FLOWS
NETWORK MODELS
OPTIMIZATION MODELS
STUDENT FLOWS
FLIGHT TRAINING

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Dynamic Student Flow model is a ~~comprehensive mathematical model~~ which applies network theory and the power of a large scale computer to schedule student naval aviators into and through training in a manner that will achieve maximum pilot production with minimum student pooling. The objective of this Users Manual is to provide non-ADP personnel with the information necessary to effectively use the system.

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UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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The Dynamic Student Flow model is a comprehensive mathematical model which applies network theory and the power of a large scale computer to schedule student naval aviators into and through training in a manner that will achieve maximum pilot production with minimum student pooling. The objective of this Users Manual is to provide non-ADP personnel with the information necessary to effectively use the system.

Research Supported by
Contract N00014-80-C-0169
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USERS MANUAL FOR THE DYNAMIC STUDENT FLOW MODEL

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SECTION 1. GENERAL

1.1 Purpose of the Users Manual. The objective of the Users Manual for the Dynamic Student Flow Model (DSFM) is to provide the user's non-ADP personnel with the information necessary to effectively use the system.

The DSFM is a computer-based system using network flow theory for producing explicit flow solutions representing the maximum throughput of flight students with the minimum time to train. A rigorous optimizing algorithm computes the flows. A principal result is the student pilot input and output schedules including data for analyses of the jet, prop and helo pipeline flows. The schedules are produced for a time period of interest, say three years, and may reflect a wide variety of planning criteria. The scope of the DSFM embraces the Undergraduate Pilot Training (UPT) program and the community of Fleet Readiness Squadrons (FRSs). The structure of the DSFM is a network wherein the various training activities and their geographic locations may be distinctly represented.

The system is exceedingly flexible at the executive, staff and managerial levels of application. The model has a powerful ability to represent a wide variety of scenarios through the conversion of standing or projected operational data and the processing of that data in a transparent, albeit very formal, manner so as to produce solution with certain optimal properties. It would not be

practical to attempt the definition of all possible variations in the use of the DSFM. Accordingly, the expository method that will be followed in setting forth the user information is to describe a normal application with indications of some of the variations. Other variations will become self-evident in the familiarity that comes with the continued use of the DSFM. Any known restrictions on the use of the DSFM will be explicitly pointed out.

It is of fundamental importance that it be understood throughout this document that the DSFM projects the systemic effects through the training network of local operating conditions at the phase level. In that sense it is a macro model which is a relative term. Local conditions and changes thereto which affect phase capacity and time to train are generally well known to the local command. The DSFM answers the larger and more difficult question of what the overall effect of local change would be on system throughput and the time phasing of that change. If, for example, Phase X at Base Y goes from a five-day to a six-day workweek, the increase in phase productivity at Base Y is determined locally. The end result of this change is calculated by the DSFM and the systemic effect may be substantially different from the intuitive expectation. Once a student flow solution has been obtained, then the DSFM can report on the personnel and material resources required to support the flight hour activity and aircraft ownership.

1.2 Project References.

a. The DSFM task was first formally proposed by Reference [1] in July 1977. Reference [2] in January 1978 changed the work period to 1 January 1978 through 31 December 1979.

b. Reference [3] is a technical report that documents the results of exercising a comparatively primitive version of the DSFM on a number of scenarios concerning base closing and squadron decomissionings.

c. Reference [4] is a follow-on technical report that documents the results of exercising an improved version of the DSFM on six distinctly different scenarios. Each scenario emphasizes some particular capability of the model, illustrating its flexibility at the executive, staff, and managerial levels of application. Certain strengths and weaknesses of this version of the DSFM also became readily apparent.

d. Reference [5] is the Overview Manual on the DSFM. This document provides a broad nontechnical description of the model beamed to the executive with little time for details. Potential users with an uncertain interest in the

model will find adequate definition therein to justify or dismiss further inquiry.

e. Reference [6] is the Functional Description for the DSFM.

f. In addition to this Users Manual and the above documents, the following system documents will be provided.

(1) Program Specifications and Maintenance Manual

(2) Program Listings

g. An operational version of the DSFM computer program, written in PL1, will be delivered suitable for installation in an environment similar to the one described in Section 4 of the Functional Description (Reference [6]).

h. This Users Manual and other system documentation to follow is being prepared in conformance with the standards set forth in Reference [7].

1.3 Terms and Abbreviations. The terms of reference as used herein will be defined when first used. A complete glossary is contained in Appendix A.

In the interests of brevity, clarity and precision, a number of symbols and abbreviations are used in describing the use of the DSFM. These will be defined when first used and a full listing is contained in Appendix B. Codes which are peculiar to the computer program will be avoided.

1.4 Security and Privacy. The DSFM does not use nor does it generate any classified information. It contains no data affected by the Privacy Act.

SECTION 2. SYSTEM SUMMARY

2.1 System Application. The DSFM is designed to assist senior staffs in the chain of command for Naval Aviation training to manage the production process for converting untrained candidates from a variety of sources into competent Naval Aviators who are qualified to join fleet operating squadrons. Although resources for pilot training must be shared with other communities, particularly at the Naval Aviation Schools Command (NASC) and the Fleet Readiness Squadron (FRS) level, only pilot training is considered by the DSFM at this time.

The model will:

a. Aid in determining whether planned production goals can still be met given a training resource crisis situation.

b. Aid in reducing the impact of changes in available student pilots, training aircraft, maintenance support, instructor pilots, funds and other resources.

c. Aid in identifying the optimal allocation of training resources in response to a crisis situation.

d. Aid in the identification of critical constraints and the quantification of any penalty incurred because of the constraints.

e. Identify slack resources which may be released or reassigned.

f. Aid managers in planning phase-in of major changes to the curriculum.

2.1.1 Purpose of the System. Constant change is a fundamental reality under which Naval Aviation training is conducted. Frequent changes in required Pilot Training Rates (PTR), resources available, fleet squadron operating conditions and a variety of lesser things keeps the training system in a constant state of flux. Under these circumstances, manual manipulation of data is inadequate to detect anomalies in student flow in time to do something about them and to prescribe remedial measures to correct an out-of-kilter condition. Increased cost to train or loss of irreplaceable student throughput results from lack of adequate and timely information to senior staffs. The DSFM combines the computational power of a computer with a well known algorithm to define an optimal mathematical solution which will assure maximum student completions with minimum time to train under the real or hypothetical circumstances prescribed by the analyst. The DSFM is designed to assist commanders in promoting system efficiency through more precise control of student flow than would be available through manual means. It also facilitates prediction of the proximate results, in terms of training capacity and student completion schedules, of changes in pilot training policy or circumstances.

2.1.2 Operating Improvements Provided by the System. Significant savings can be realized through more precise control of student inputs to the system and through improved distribution of students among elements of the system after those students have begun individual training. As an example of the order of magnitude of savings which are possible, the DSFM generated schedule for input of student pilots into Primary flight training in FY-79 resulted in about 100 fewer student man-years spent in pools than was predicted for the manually generated input schedule. Improved efficiency will result from the increase in the predicted time span which can be comprehended by the manager as a result of computer supplied data, and from the ability of the manager to detect anomalies in the system in a more timely manner once he is relieved of the tedious and time consuming tasks involved in manual manipulation of student flow data.

2.1.3 System Characteristics. The DSFM does not provide push-button solutions to student flow problems. Instead, it provides a rigorous mathematical description of student flow through the pilot training system as that system and its operating circumstances and resources are described by the analyst for the DSFM. The accuracy of prediction of student flow is thus absolutely dependent upon the skill with which the analyst translates real-world operating factors into training capacity and time to train of each segment of the pilot training network. That network embraces the entire continuum extending from initial entry into pilot training through completion of FRS training. However, since some segments of the network exhibit distinctive traits which are not common to other segments, it will be described as three subsystems.

2.1.3.1 Undergraduate Pilot Training (UPT) Subsystem. The heart of the DSFM is a rigorous algorithm producing optimum student flows through that portion of the training continuum extending from entry into primary flight training through designation as a Naval Aviator on completion of UPT. During this portion of the training continuum, student populations within each pipeline are reasonably homogeneous and the pipeline curriculum provides a structured path along which the student must progress. These operating conditions make explicit projections of student flow through UPT reasonably attainable.

2.1.3.2 Naval Aviation Schools Command (NASC) Subsystem. The pre-primary schooling of prospective flight students is somewhat less amenable to precise control than is UPT. Although the curriculum is structured, student populations are non-homogeneous. They are drawn from diverse sources such as the Naval Academy, NROTC and the Aviation Officer Candidate program in numbers subjectively determined to provide the best population for subsequent flight training. Historically, different attrition rates are experienced for each entry source. Lack of formal criteria for determining the mix of students from the various sources precludes automated scheduling of their entry. The importance of NASC input schedules to the subsequent student flow is recognized. The DSFM provides for rigorous analysis of the impact of subjective decisions on student input schedules. It can accept the results of the subjective decisions and automate production of hard-copy schedules which can provide a common base for discourse among managers at each echelon of command involved in student acquisition and scheduling.

2.1.3.3 Fleet Readiness Squadrons (FRS) Subsystem. The post-UPT portion of the continuum of training is somewhat less amenable to rigorous analysis and precise

flow control. Student populations within the FRS are non-homogeneous, being composed of various categories of Naval Aviators ranging from some who are newly designated to others who are quite senior and experienced. Curricula are also more flexible, with some training at times deferred for later accomplishment in fleet squadrons when scheduling exigencies so demand. Mathematical prediction of student flow in an FRS is therefor much less precise. In recognition of this, the FRS portion of the DSFM is constructed as a scheduling assist model.

2.2 System Operation. Various levels of detail are desirable in constructing the network representation of the training process, depending on the needs of the particular user. For example, when analyzing student input schedules required to support a prescribed PTR, it is usually sufficient to aggregate all jet training as though it was conducted at one base. On the other hand, when determining optimum distribution of graduates of the Primary Phase of training among various jet bases, the network must distinguish each base by considering the discrete training capacity and time to train for the individual training base.

2.2.1 UPT. Each time the DSFM level of detail has been increased, there has been a decrease in the throughput capacity of the UPT system. This phenomenon is also extant in the real world which the DSFM models. The more constraints placed on the way the training squadrons operate, the fewer pilots they can train. Attempts to throttle the flow of students through UPT to achieve a better match with FRS input requirements will cost something in achievable PTR. It is unlikely that such throttling will occur--at least through the decade of the 1980's. Jet training aircraft and advanced helicopter trainers are out of production. Aircraft inventories are barely adequate to meet current pilot production rates. As these aircraft inventories are diminished through attrition, the Chief of Naval Air Training, (CNATRA) will be forced to operate remaining aircraft under surge conditions. These conditions will be exacerbated as the demand for trained Naval Aviators increases. Helicopter pilot training rates will increase with the introduction of the LAMPS Mk III helicopters. Jet pilot training requirements will increase as attack carrier force levels increase from twelve to fifteen. New training aircraft will not become available to alleviate the shortage until the late 1980's.

Projected pilot inventories will, at best, be marginal to man the expected increased carrier force levels. Any shortfall in required PTR could serve as a constraint on the number of carrier squadrons available to put to sea

in support of national objectives. Good management will therefor dictate operating the CNATRA establishment--or at least the jet training portion of it--to achieve maximum throughput of pilots.

2.2.2 Fleet Readiness Squadrons.

The network has been modeled so that FRS considerations will not constrain UPT throughput. The UPT network is manipulated mathematically as an entity to optimize its output. This output of UPT then becomes the available student population for distribution to the FRSs. Although this separation of UPT and FRS flow violates the theoretical continuum of flow from UPT program entry through assignment to fleet squadrons, it closely replicates real-world practices.

Unlike UPT which is aircraft constrained and operating at near capacity at some bases, the FRS throughput is mostly constrained by restrictions on class size and convening frequency. Time to train and capacity to train can be empirically determined and held constant except during periods of transition to new aircraft types or change in squadron locations. There are, however, three specific areas where improved scheduling is apt to provide shorter mean time to train and better utilization of resources.

(1) Survival, Evasion, Resistance and Escape (SERE) scheduling.

(2) Aircraft Carrier Qualification (CQ) scheduling.

(3) Coordination of East and West Coast schedules.

2.2.2.1 SERE. This training is conducted at one location on each coast. Most pilots receive this training while enroute from UPT to their FRS assignment. Graduates of the UPT Strike, Maritime and Rotary Wing pipelines are mixed in classes of finite capacity; however, they must retain their jet, prop, or helo identity for subsequent assignments. West Coast SERE classes convene about three times per month and the East Coast about two classes per month. Since students graduate from UPT every week, there are occasions when no SERE class is immediately available. Similarly, there are times when SERE graduates cannot be accommodated by FRS covening dates without a delay of some weeks. These scheduling problems are too complex to be solved by manual means. It amounts to trying to mesh gears with fifty teeth per inch with other gears having thirty six and ten teeth per inch. While the DSFM cannot provide a perfect match, it can suggest improvements which will minimize the loss of time between a student's designation as a Naval Aviator and his entry into formal FRS training. Staggering East and West Coast class convening dates could be one area for improvement.

2.2.2.2 Aircraft Carrier (CV) Schedules. The availability of carrier decks for qualification (CQ) of jet student aviators is a major constraint on the ability of an FRS to meet scheduled completion dates for student Replacement Pilots (RP) destined for fleet squadrons. Since CV schedules are largely dictated by overseas deployment requirements, training generally takes whatever is leftover after other fleet needs are met. Anytime that a dedicated training carrier (CVT) is not available, the problem is further compounded since the fleet and UPT communities are both competing for the fleet CV deck time. While there is little likelihood that CV schedules can be modified to optimize FRS throughput, the DSFM can probably provide a better fit to available CV decks than can be achieved by manual means. As a minimum, the DSFM will be able to predict with some precision the student flow which is likely with a given schedule of CQ. CQ will be modeled as separate events for each of the jet FRSs in order to achieve this.

2.2.2.3 LANT/PAC Schedule Coordination. NAVAIRLANT and NAVAIRPAC training schedules are generally constructed independently of each other. The complexity of the scheduling problem makes it unlikely that coordination of these schedules can be achieved by manual means. The DSFM can, however, manipulate schedule parameters to obtain the best fit achievable between East and West Coast training schedules. Better utilization of student's time should result. The complexities involved in coordinating activities of the two fleets are such that it appears prudent to model the FRS subsystem of the DSFM as a scheduling assist model, rather than as an automated schedule generator. In this way, uncertainties which cannot be comprehended by computers can be resolved by human schedulers.

2.3 System Configuration. The DSFM operates in the batch mode under IBM's OS/VS1 Operating System in a half-megabyte user partition. Normal job setup and submission operations are conducted in an interactive mode under IBM's VM/370 using the standard CMS utilities.

The DSFM System is written in PL/I. All modules, with the exception of the Build Routine*, are compiled under IBM's PL/I Optimizing Compiler, a licensed program product. This licensed program must be resident on the host machine for all system execution and maintenance. In addition, in order to load the DSFM System Tape, the disk storage equivalent of about 525 tracks of 3330

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* The Build Routine is compiled under the PL/I 'F' Compiler which pre-dates program licensing and is currently unsupported by IBM. A copy of this compiler and its resident library are included on the DSFM System Tape.

disk space is required. Execution of the model requires two to ten tracks of 3330 disk space for each training system modeled and a similar amount for each solution to be retained.

The developmental hardware and support software for the DSFM has been configured as follows:

a. Developmental Hardware.

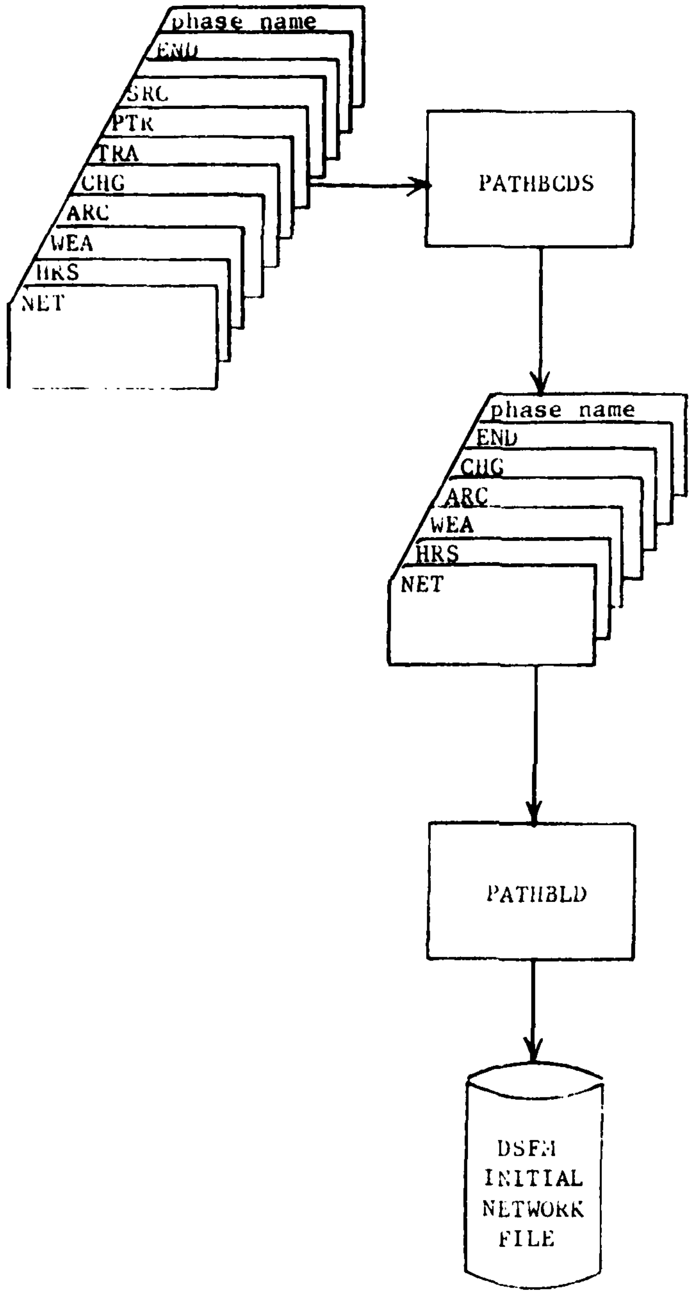
1 IBM 370/148 CPU with 2 megabytes of real memory
6 3330-1 Disc Drives
2 3330-11 Disc Drives
4 3350 Disc Drives
7 3420-5 Tape Drives (800BPI/1600BPI)
2 3203 Printers
1 3505 Card Reader
1 3525 Card Punch
1 3705 Telecommunications Controller
1 Data 100 RJE Station

b. Developmental Software.

OS/VSI Release 6.0E- Operating System
JESI Job Entry Subsystem
RES Remote Job Entry Subsystem
APLSV Dial-up Time Sharing Language
6 256K User Problem Program Partitions (1024 K Partition on req.)
PL/I Optimizing Compiler
VM/370 Facility

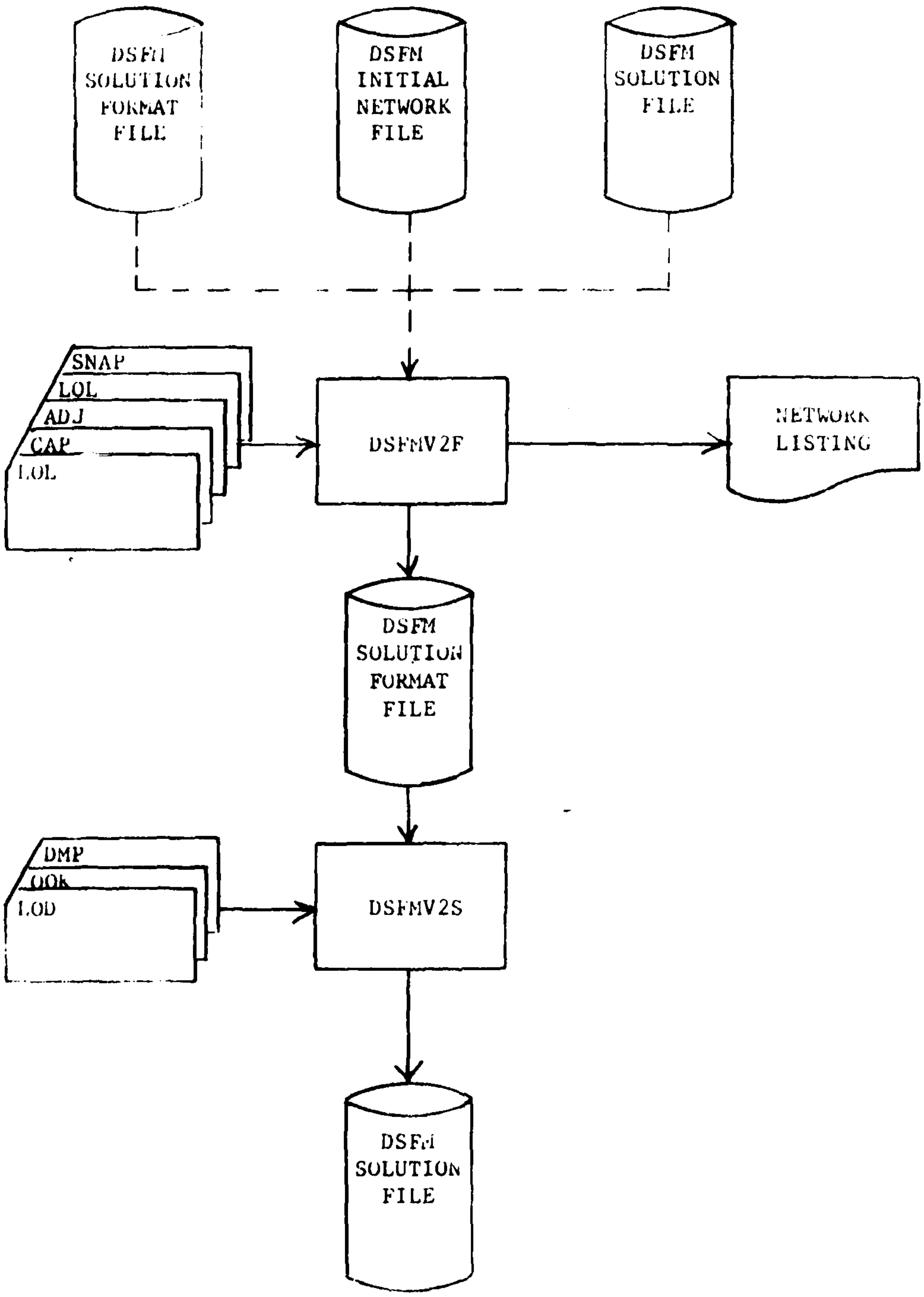
2.4 System Organization.

2.4.1 Program Architecture. The DSFM computer program has been designed around six executable modules as delineated in Figures 2.1 through 2.3. Each functional subsystem in 2.4.2 has the same executable modules. The subsystems are distinguished only by the network representation and interpretation of the arc parameters. The following subparagraphs discuss each executable module briefly only to indicate to the user the major components of the DSFM. The more comprehensive description is contained in the Program Specification and Maintenance Manual.



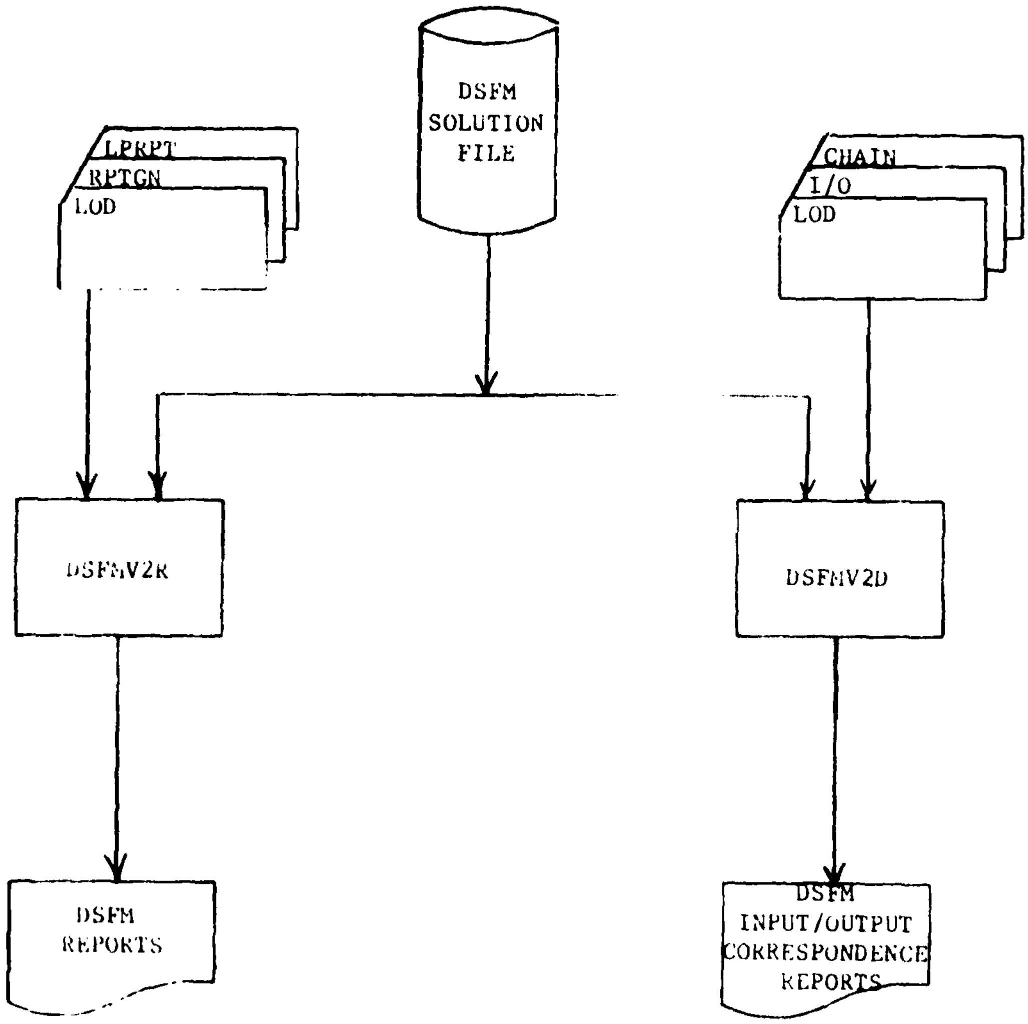
Building a Network

Figure 2.1



Adjust Network Parameters
&
Obtain Solution

Figure 2.2



Network Report Generation

Figure 2.3

Generate Network Build Control Cards (PATHBCDS): (Fig. 2.1) This program will build control cards for the PATHBLD program. It is generally used to describe other than training phases for a DSFM Network. However, it can also be used to describe fixed length training phases, i.e., when describing a NASC Network.

Build DSFM Network (PATHBLD): (Fig. 2.1) This program accepts control cards which describes a DSFM Network and constructs the initial version of that network. This initial version contains all of the arcs and nodes, their connecting linkages, and the network name, none of which may be changed by subsequent processing.

Adjust/Display Full Network (DSFMV2F): (Fig. 2.2) This program will load a DSFM Network, alter arc parameters, display network statistics, arc parameters, and network construction details, and dump the network in a form suitable for solution, report generation, and input/output correspondence analysis. The network loaded may be an initial network from the PATHBLD Routine or a solution formatted network from a previous execution of either the DSFMV2F or DSFMV2S programs. The arc parameters which may be altered are upper bound on flow, lower bound on flow, and cost. The only practical restriction on the alteration of arc parameters is that neither the upper bound nor the lower bound may be set in conflict with each other. Network statistics displayed include network size and grouping information. For each arc group, its index, name, node codes, size, associated attrition information, and beginning Network Listing page number are given. Arc parameters and network construction details are provided in a Network Listing. This listing displays parametric and construction information for five arcs to the line. Flow, upper bound on flow, and lower bound on flow values listed for each arc are all in terms of pipeline graduates. The five arcs displayed on a single line have 'FROM' and 'TO' nodes which differ only by year. The dumping routing first analyzes the network, its parameters, and its flow, if any, to determine which arcs may participate in a solution. Arcs which may participate in a flow solution are flagged as members of a network cross section as they are dumped to disk.

Generate DSFM Solution (DSFMV2S): (Fig. 2.2) This program will load the network cross section consisting of only those arcs that may participate in a flow solution. It will then apply the Out-of-Kilter Algorithm* to generate a minimum cost solution. A full copy of the network containing this solution is then stored on the disk.

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* See Appendix A of Reference [6].

Generate DSFM Reports (DSFMV2R): (Fig. 2.3) This program generates all DSFM Reports with the exception of the Network and the Input/Output Correspondence listings. The primary routine is a Report Generation Interpreter. It reads control cards to direct the generation of a report, line by line. Average or total weekly, quarterly, or yearly values may be displayed by individual or collections of arc groups for the following data elements.

Input Students
Output Students
Onboard Students
Attrited Students
Input Student Capacity
Output Student Capacity
Onboard Student Capacity
Unused Input capacity
Unused output capacity

In addition to the above data elements, resource requirements, either utilized or planned, which may be calculated as a factor times students trained or training capacity, respectively, may be displayed as described above. Examples of such resources are Aircraft and Instructor Hours.

This program also contains a routine to display Loading Plan information. It reads control cards to describe columnar information to be displayed by phase inputs. The values displayed may be planned values as predicted by the DSFM or directly entered values for actual historical inputs.

Generate Input/Output Correspondence Tables (DSFMV2D): (Fig. 2.3) This routine will display, by graduation week, phase graduates and their source and entry week for each pipeline represented in the network solution. In addition, this routine will display one set of chains representing a decomposition of the solution. This latter output is intended primarily for the DSFM Analyst.

2.4.2 Functional Subsystem. Although there is no theoretical or constructive requirements to do so, in practice, the DSFM has been divided into three subsystems: UPT, NASC and FRS. The DSFM UPT Subsystem is represented by a network model of UPT starting with Primary flight training and ending with designation as Naval Aviators or attrition. It is supported by an NASC Subsystem which provides schedules for inputs into the NASC and predicts the outputs of NASC which are thence available for entry into primary flight training. The predicted output of designated Naval Aviators from UPT becomes the source population for

entry into an FRS training subsystem. This division of the DSFM into three parts is suboptimization in the strict sense of the continuous flow of students from entry into UPT until they are assigned to a fleet squadron, however, there is general agreement within the training community that the UPT program is the critical link in the production process. Moreover, any partitioning of the total network has a practical payoff in terms of data processing storage space and running time.

2.5 Performance. Separation of the DSFM into three interrelated, but distinct subsystems (UPT, NASC, FRS) will facilitate outputs tailored to the needs of a variety of users. The interests of the Naval Military Personnel Command (NMPC) will be largely served by providing updated student input schedules needed to meet prescribed PTR's. OPNAV will, on the other hand, be concerned with all three programs since their responsibilities span the entire continuum from Student Naval Aviator (SNA) accessions through FRS training. CNATRA will be concerned with the NASC and UPT subsystems to help him control the production process for training Naval Aviators and to assist him to plan the acquisition and application of resources of all kinds. Structuring the DSFM into three distinct subsystems will have the collateral benefit of reducing preparation and running time for the user who requires only a subset of the total program output.

For UPT, the DSFM solutions can also be decomposed into separate paths by week of entrance into flight training, with students tracked until graduation or attrition from the program. A report can be generated which relates pipeline graduation to time of entry into the program. This report would provide a convenient device for scheduling student inputs by source since the DSFM does not distinguish among the different student sources, i.e., Navy AOC, Navy Officers, Marine Corps Officers, etc. Improved prediction of graduation dates would also benefit Navy and Marine Corps detailers and the people they must detail to fleet assignments.

2.5.1 System Functions. Through the use of a responsive data processing system the DSFM was designed to provide the following particular capabilities.

a. Produce a schedule of student weekly inputs into Primary flight training over a one to three year projected period stating the requirements for an optimal student flow through all the pipelines under the conditions of a given scenario.

b. Produce a suitably formatted schedule of student weekly inputs into the NASC over a one to three year projected period which provides the entrants for the schedule produced in (a) above or any other feasible schedule.

c. Determine the maximum throughput of the training system for a given scenario with shortfalls, when occurring, to the PTR explicitly stated by pipeline and year.

d. Determine required capacity to train by weeks, phase, and location to produce a given set of PTRs.

e. Determine where the training bottlenecks are in the system.

f. Determine where excess capacities exist in the system.

g. Determine the surge capacity of the system if additional personnel, spare parts, funds, etc., were made available to increase the aircraft utilization.

h. Determine the expected number of student-weeks spent in pools and their location which will result from a given plan or policy.

i. Provide information leading to improved PTR assignments to training wings and squadrons.

j. Provide data for staff analysis leading to improved pipeline balancing of capacities to train by phase and location.

k. Provide expected tracks for students to follow as they enter the system at a particular week.

l. Provide a measure of the effect of different planning policies and scheduling criteria e.g., level input, level output, uniform student loading.

m. Provide flying hour requirements for UPT and the aircraft, personnel and O&MN/APN/MPN costs to support the flying hour program.

n. Match UPT output schedules with FRS input schedules.

o. Match FRS output schedules with planned fleet squadron requirements for replacement pilots.

p. Assist staffs in planning for transition to new equipment, facilities or curriculum.

2.5.2 Inputs. All input data is taken directly from data which is routinely collected, is derived from such data, or is management information of the kind normally within the purview of one of the staff divisions. No special data collection program is required.

2.5.3 Outputs. These are represented by a catalog of standard formatted reports derived from the student flow data in a particular network solution. Ancillary files are sometimes needed in the conversion of solution data to report data. Reports are geared to the executive, staff and analyst levels with aggregations at the annual, quarterly and weekly intervals, respectively.

2.5.4 Processing Time. There are two major processing executions that the DSFM does:

- Build a network and make arc parameter adjustments, and
- Compute optimal student flow solutions.

If we say that a typical UPT network has about 3300 nodes and 6500 arcs, then:

- Build a network takes about 2.0 minutes, and
- Solution takes about 2.5 minutes.

Arcs and nodes have not been explicitly defined at this point. Nodes are analogous to the hubs in a Tinker Toy set and the arcs are the spokes connecting the hubs.

UPT networks take on many different sizes depending on the detail desired but 6500 arcs is a typically useful size UPT network.

2.5.5 Response Time. Turnaround times can be a function of several factors in addition to processing times. One such factor is the degree which the user command can set priorities on the processing sequence of programs in the computation center. The DSFM is strictly a batch processing operation. The online storage requirements are large for most practical networks. Consequently, the operations manager of the processing system may prefer a third shift batching of the larger programs. In general, overnight turnaround for routine DSFM runs is probably adequate. When new networks have to be constructed, a preparatory overnight period should be anticipated for that purpose.

2.5.6 Limitations. As mentioned above, the current version of the DSFM is strictly a batch processing operation and for the full scope of the capabilities as described in this manual, it should remain so. There are spinoff versions, however, that would be amenable to an interactive mode of operation. These would still depend on a DSFM solution as described herein. Two interactive ancillary capabilities suggest themselves.

a. Terminal interaction with the structured files of student flow data produced by a DSFM optimal flow solution. The current DSFM capabilities are very close to that now as described under flexibity below.

b. Terminal interaction on a structured file of the various projected paths that students entering UPT Primary at a certain week follow to finish a particular pipeline at the end of a specified week. This could serve as a convenient input-output planning tool where the different student sources and attrition rates come into play.

2.5.7 Flexibility.

a. The network structure is user defined. There is no theoretical limit to its size or configuration. The rules for construction are few and simple. Some skill is required, however, in interpreting the real world (whether actual or hypothetical) in terms of arcs and the operational parameters placed on them.

b. The family of standard outputs as described in Section 3, although broad in scope, is by no means a fixed limit. Many other varieties can be defined on the data contained in the optimal student flow solution and produced with no great difficulty. Programmatic changes are not required.

2.5.8 Error Rate. Adequate provisions have been incorporated in the DSFM program for legal and logical error detection and correction. Certain roundoff discrepancies in the outputs may become evident, however, because of student attrition of small percentages. These percentages first decrement student flows and then increment the flows and, as a consequence, the calculations do not always return to the starting values. Although the error is not significant, it is unsightly.

2.6 Data Base.

2.6.1 Network Files. The data base as viewed by the staff DSFM Analyst will be largely a library of stored networks complete with all the arc parameters. His routine changes will be made to one of these networks, each with a unique ID, and rerun either to update with a new start time or to represent a change to the operating circumstances, either real or hypothetical.

2.6.2 Input Files. Experience to date has shown that the raw input data can be contained in various forms and kept in three-ring binders on the DSFM Analyst's bookshelf. If, however, he would prefer to move to a more automated level, he could certainly do so and the formatting of the data would depend strictly on the local arrangement between him and the supporting EDP facility. Some of the management information with which he will be dealing will be so unstructured and transient in nature that it will be more practicable to retain it in whatever free form is suitable.

2.6.3 Responsibilities. The scope and quality of the DSFM input data as contained in the Network Files and elsewhere is the responsibility of the staff DSFM Analyst. The faithful conversion and maintenance of the integrity of the data as turned over to the EDP facility is, of course, the responsibility of that facility.

2.7 General Description of Inputs, Processing, Outputs.

2.7.1 Inputs. Routine input information for the DSFM is acquired from routine sources. Relevant ad hoc information is acquired and applied as the judgment of the staff DSFM Analyst dictates. The characteristic routine information used in the three subsystems of the DSFM is described below.

a. UPT Subsystem. The following inputs are required as source data to prepare the input parameters for the UPT network.

(1) PTRs by pipeline for the time period of interest, normally three to five years.

(2) A list of the training phases and their sequence in the flight training process. Include delay times, if any, for each phase-to-phase transition.

(3) For each phase, location, and type aircraft:

(a) average weeks to train

(b) attrition rate for students in each phase of training

(c) average total aircraft, simulator and instructor hours per phase graduate (includes all overhead hours)

(d) percentage of flyable weather by month

(e) daylight hours per day by monthly averages

(4) Inventories of aircraft and their simulators by type, phase and location by quarter of each fiscal year during the time period of interest. The expected annual utilization of each type aircraft and simulator is also required.

(5) Student onboard loads and student pools by phase and location as of the start date of the DSFM exercise.

(6) Student input schedule into the NASC that is effective during the time period of interest.

b. NASC Subsystem. This subsystem requires the following information on each category of students that are to enter the NASC. Categories may be by service or by various sources within a service, e.g., Navy AOC and AVROC.

(1) Minimum and maximum number available during each fiscal year.

(2) Preferred periods of times for their entry into NASC.

(3) Attrition rate in NASC and pipeline attritions in UPT flight training.

The following data is needed on the NASC classes.

(4) Minimum number, if any, desired in each weekly class.

(5) Duration in weeks and maximum class size.

(6) Nominal percentages of SNAs in a class.

Normally, the NASC Subsystem is run against a list of desired weekly inputs into the Primary flight training phase which is a product of the UPT Subsystem, however, this is not absolutely necessary to the running of the NASC Subsystem.

c. FRS Subsystem. The following is the essential data for this subsystem.

(1) A list of the jet, prop and helo FRSs by name, type aircraft and location.

(2) The Op-59 schedule of FRS classes for current and previous year for SERE, jet, prop and helo FRSs. This schedule contains start and finish times and number of CAT I students in each class.

(3) Table of nominal transit times between UPT to SERE to FRS.

(4) Onboard load of CAT I at each FRS on the starting date of the OSFM exercise.

(5) CAT I attrition rates at each FRS.

2.7.2 Processing. There are two general categories of processing: (1) Building networks and (2) Solving networks.

The first is required when there is a change in the detail to be delineated in the network, either more or less, or when there is a change to the average time to train in some phase of the network. Either of these alters the structure of the network and requires a rebuilding.

The second, which is where most of the processing time will occur, is simply the modification of an existing network. This requires an entry describing the changes and then finding a new flow solution based on the changed conditions. Outputs are based on the new flow solution and may be compared with the old. Usually this does not involve a lot of human intervention or analysis.

2.7.3 Outputs. The outputs are geared for the executive, staff and analyst levels with time intervals as annual, quarterly and weekly, respectively. These outputs are routinely grouped under the following headings:

a. Executive Summary

b. Staff Summary, and

c. Analyst Report.

The Executive Summary is a one page report which is intended to convey the annual expectations. If there is trouble ahead, such as shortfalls in the PTR, then it becomes an alerting device that action is required to avert the unwanted event. This is the main purpose of the DSFM, to project problem areas in time to prevent them from occurring.

The Staff Summary is both a planning and management tool. The projections here are more specific than the Executive Summary with respect to seasonal variations and perhaps other aberrations in the planning cycle. It puts the staff in a much better position to advise the command on whether production is on track or off and to what extent management changes are appropriate.

The Analyst Report is neither a planning or management tool. It is intended primarily as a tool for the staff DSFM Analyst to more fully comprehend the trends and cyclic changes that are occurring within the system. The DSFM Analyst is the primary advisor to the various elements on the staff as to why the DSFM projections are the way they are. They do not always project the intuitive expections of experienced staff personnel. When they differ, an investigation into why is called for and, as experienced so far, the intuitive expection is often the correct one. The algorithm contained in the DSFM does not lie. What frequently occurs is that the input which represents a change in operating circumstances is not as representative as intended. There are instances where experienced intuition is just plain wrong. The Analyst Report provides the detailed information for separating the two.

SECTION 3. STAFF FUNCTIONS RELATED TO TECHNICAL OPERATIONS

The DSFM is a potentially powerful and flexible planning and management tool but there is an essential interface between the model and the relevant scenarios that shape the solutions produced by the model. It is of fundamental importance that a knowledgeable, responsible person be designated who understands both sides, the capabilities of the model, on the one hand, and the proper interpretation of the scenario in terms of inputs to the model, on the other. While the DSFM will not be able to cope with all conceivable scenarios, the extent to which its capabilities can be exploited will depend on the proficiency of this individual. That key person is the designated Staff DSFM Analyst. The duties of the DSFM Analyst are briefly summarized in the following paragraphs.

a. Routine Reports. Provide routine periodic SNA flow projections under the existing and expected operating conditions for a three year period. These outputs are to be provided to all interested levels and divisions in the staff. These will provide a common structure for discourse within the staff, subordinate commands and, to the extent the command wishes, external commands and staffs. These routine projections will represent the real life expectations of production for aviators within the training command. For these to be truly realistic will require that the DSFM Analyst be 'on top of the situation' in the sense of good inputs and timely updates. Direct informal contact with the TRAWING Staffs should be authorized. He should earn and maintain their confidence that privileged information concerning management actions, current and future, will not be abused.

b. Ad Hoc Reports. WHIF drills (hypothetical scenarios) are an integral part of staff day-to-day evolutions. Often they are a result of external stimuli but when you have a wholly-owned comprehensive management tool such as the DSFM, internal demands for experimental runs will become a considerable part of the DSFM executions. For example, if we go to a 5-1/2 day flying week, what will be the PTR change and when will it occur? How should we phase in the extended work week to keep the pipeline flows in balance? The DSFM Analyst will know how to interpret this WHIF in terms that are meaningful to the model. Equally important, he will know the right questions to ask the party making the request.

c. Output Analysis. The logic built into the DSFM is rigorous and the solutions are certain with respect to maximum student flow and minimum time to train. Nonetheless, solutions based on new operating conditions, for example, do not always conform to the expectations based on staff intuition. When this occurs, the DSFM Analyst may be asked to analyze the result to determine the reason the results are what they are. The DSFM is geared to produce a variety of information for the express purpose of this kind of analysis but the investigation may be very time consuming anyway. As experience is gained, there will be fewer and fewer new questions, however.

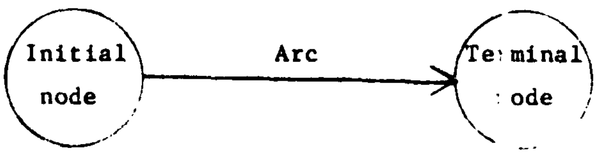
d. Data Files. Files containing DSFM input data must be maintained. These files will contain information to the extent the DSFM Analyst considers necessary and may be structured or unstructured as he wishes.

e. ADP Interface. The DSFM Analyst serves as the single point of contact between the user staff and the supporting data processing activity. He may

be a member of the data processing activity providing the activity is organic to the staff, otherwise, he should be a staff member. Some ADP experience would be very valuable in his role as go-between. The formatting of input data will be as required by the local relationship between the DSFM Analyst and the data processing activity.

3.1 Initiation Procedures. The DSFM is designed for batch processing. The procedure for initiating a DSFM execution is essentially a conversational one. The staff member who initiates a run request discusses his needs with the DSFM Analyst who in turn will list the essential input requirements to formalize the job request. This is the most practical procedure for utilizing the DSFM. While it is possible that job requests could be formatted, that would require that each individual staff user would have to learn more about the DSFM than he would care to learn. With the DSFM Analyst serving as the translator, we need train only one person who can then respond to all potential users with an authoritative voice.

3.2 Staff Input Requirements. This introductory paragraph on DSFM inputs will set forth a framework for the more detailed discussion to follow on the acquisition and preparation of the various inputs to the model. Fundamentally, the structure of the DSFM is a network composed of arcs and nodes as illustrated below.



Each node has a unique NAME. The NAME is in three parts, XYZ, where:

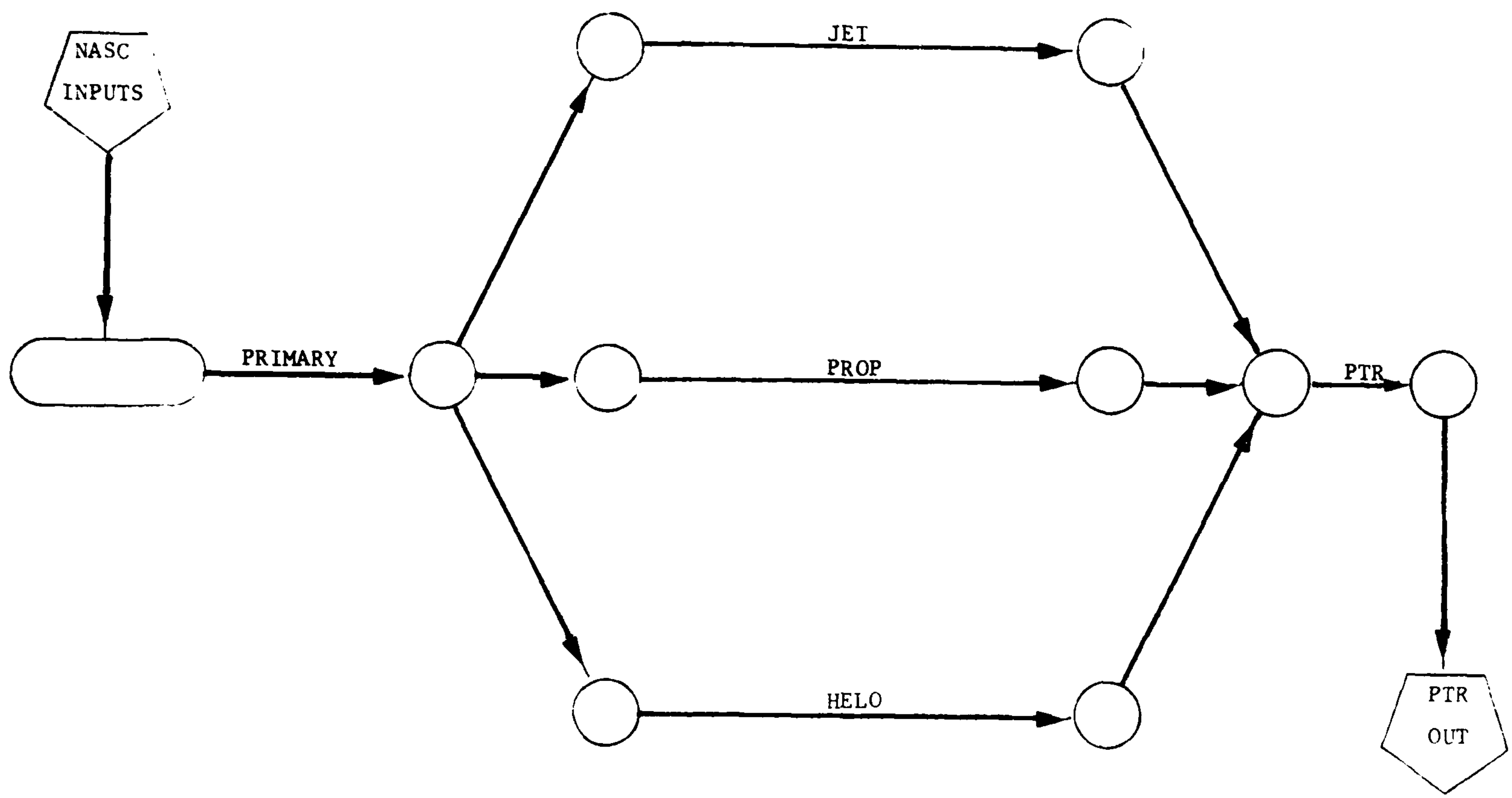
X is an alpha character identifying that class of nodes,e.g., initial node of the Primary flight phase,

Y is the sequence number of the fiscal year, 1 through 5, e.g., the start time for the DSFM is in FY80, then '1' would indicate FY80 and '5' would indicate FY84, and

Z is a number indicating the week number, 1 through 52, in the fiscal year.

Hereafter, X, Y and Z will be referred to as defined above.

An extremely primitive representation of the UPT network is sketched in Figure 3.1. This is a static display so in order to achieve the dynamic dimension that is required the network must be expanded in time, week by week,



Elementary UPT Network

Figure 3.1

because that is the scheduling interval for starting classes in the UPT system. When we expand the network in Figure 3.1 as shown in Figure 3.2, we can see how rapidly the number of arcs and nodes proliferate.

Each arc is assigned three parameters:

Time duration in weeks* ,

Maximum capacity, and

Minimum capacity in the number of students per week.

The time duration of an arc is always equal to the year and week (the YZ) of the terminal node minus the year and week of the initial node except when including any part of the Christmas holidays. When a Christmas holiday week is included it is automatically counted as zero. The time duration of an arc may be zero, but is never negative. If the arc represents a phase of training, such as Primary, then the time duration would be the expected time to train for a student entering the phase at the time (the YZ) of the initial node. He would be expected to complete the phase at the end of the week immediately preceding the time of the terminal node - - ready to start the next event at the time (YZ) of the terminal node.

The maximum and minimum capacities are two non-negative numbers where the minimum is, of course, never greater than the maximum. For a feasible flow solution, the flow in every arc must be on or between these upper and lower bounds. The upper bound may be thought of as the 'permitted' flow and the lower as the 'required flow'. The lower bound is very useful when a fixed flow is essential such as an established student input schedule. The arc capacities are effective for events which start at the time (YZ) of the initial node.

The DSFM comprehends only time durations and capacities, but the arcs in the network must represent a variety of events and activities. The delineation in Figure 3.3 is strictly an expository device for grouping the DSFM arcs by function in a common framework of reference. The different interpretations one may assign to the arc capacity and time to train according to the arc's function will be indicated briefly here by way of introduction before describing the input requirements in detail. As the full exposition develops, it will be seen that a variety of operational and management information can be represented through the knowledgeable use of the time and capacity arc parameters. With reference to Figure 3.3 then:

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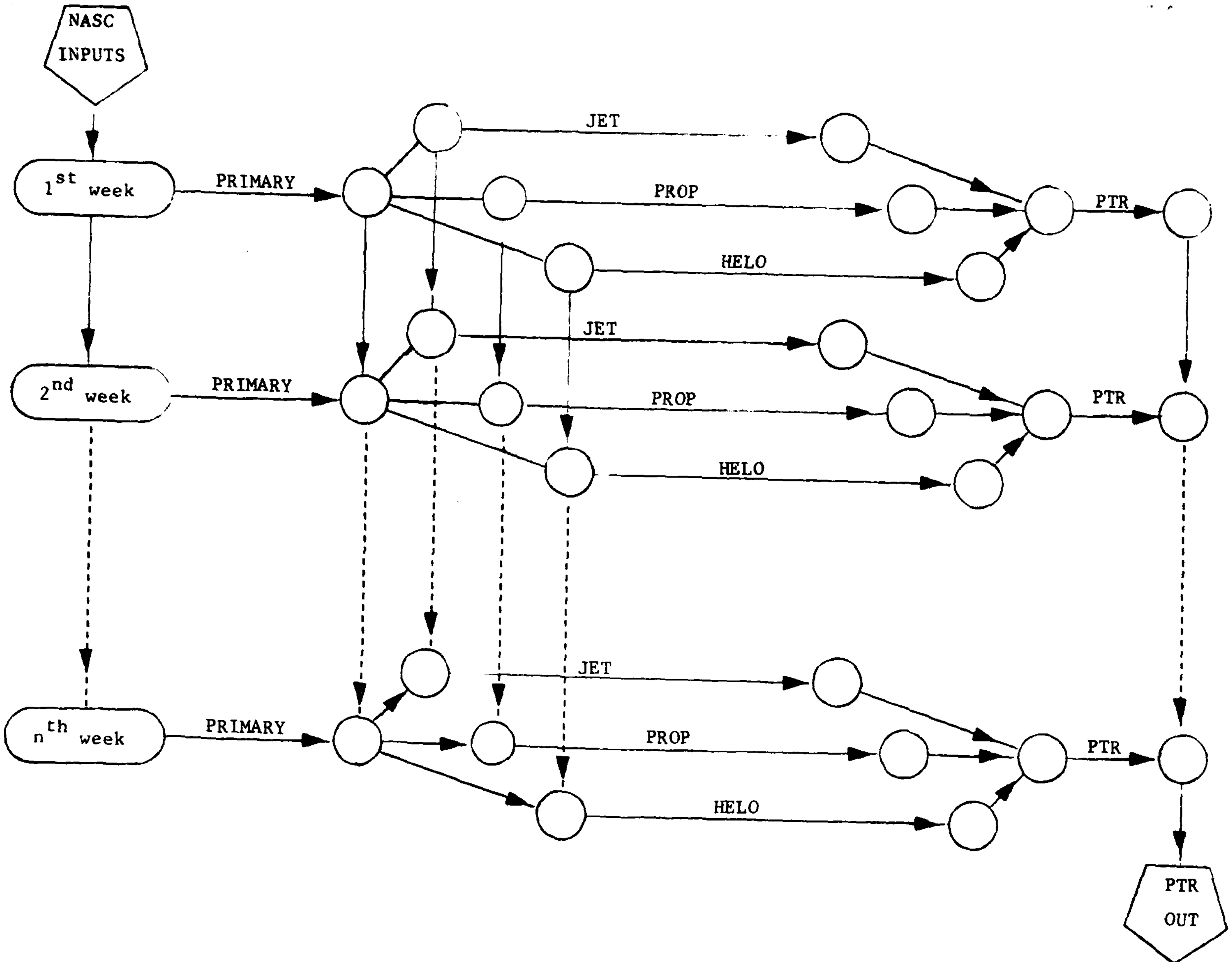
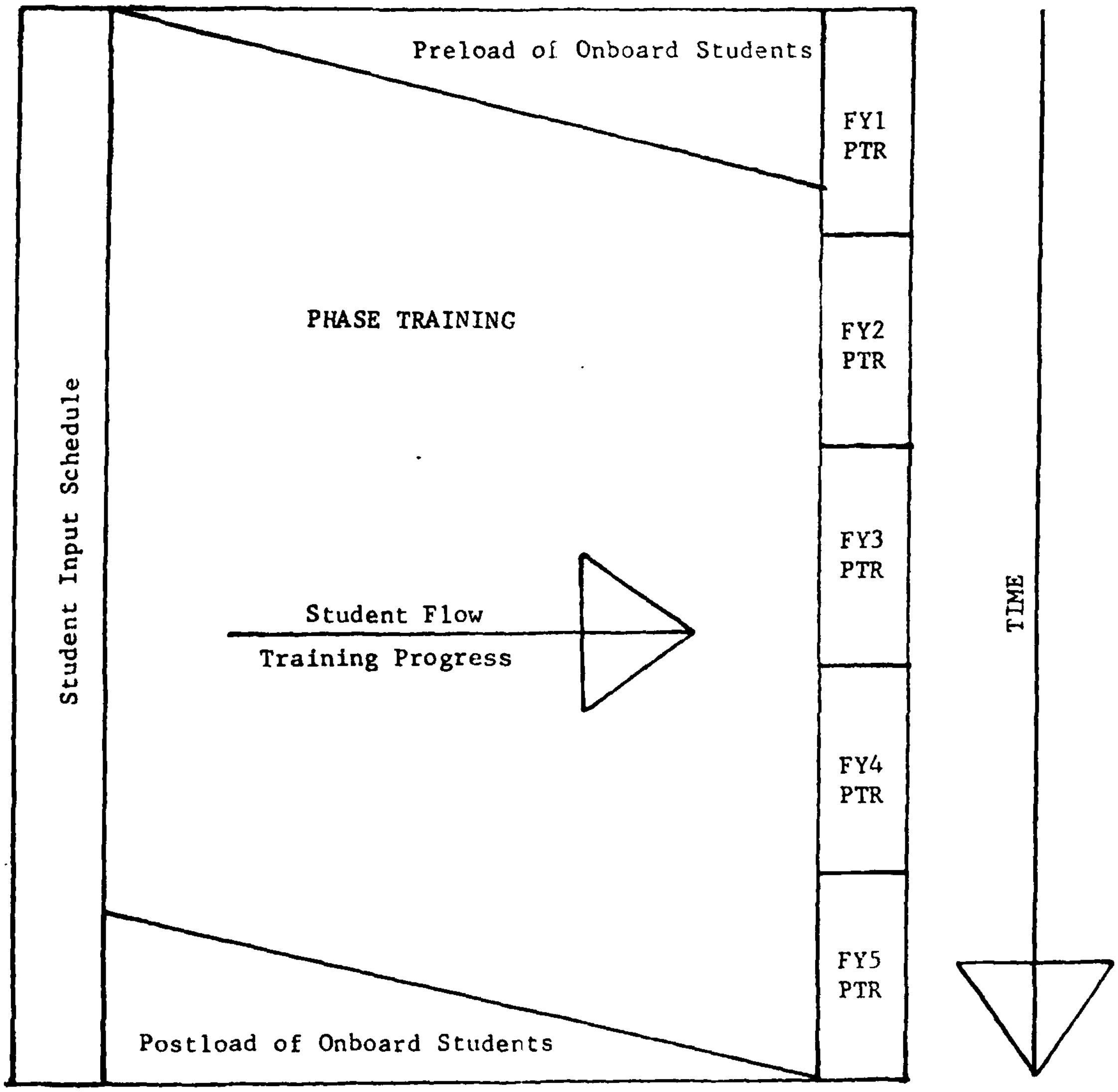
* In Section 4, Advanced Techniques, a powerful option is described where this parameter does not necessarily represent time but it would be a distraction to introduce the technique at this point in the development.



Time-expanded Elementary UPT Network

Figure 3.2



Categories of Arcs in the UPT DSFM Network

Figure 3.3

Student Input Schedule. The input schedule of students into the Naval Aviation Schools Command (NASC) is formally published each year for the following fiscal year. Changes are sometimes made during the year to reflect changing conditions or experience. To the extent that an input schedule is known, the min/max capacities of the weekly input arcs would be indentical, i.e., the minimum required and the maximum allowed are the same. Beyond that time period, one can set the upper capacity to infinity and the lower to zero and let the DSFM solve for the optimal input schedule of students. Alternatively, one can do the same for the entire five-year time period and compare the optimum schedule with the existing input schedule. Intermediate constraints on the available input schedules are clearly possible. The time duration of these input arcs is zero.

Preload of Onboard Students. The DSFM can be initiated at any time during the year that the onboard student load is known. These students are called the Preload. If the best estimate of the distribution of onboard students is that they are evenly distributed with respect to weeks-to-go-in-phase, then the phase length (in weeks) minus one* is divided into the number of students to determine the size of each preload (onboard) class. These classes then have one week-to-go, two weeks-to-go, etc. If there is reason to believe that the onboard students are not uniformly distributed in the weeks-to-go-in-phase, then the actual or estimated distribution can be entered accordingly. The time duration of each preload arc is equal to the weeks-to-go for the class represented, i.e., 1,2,..., time duration minus one. The min/max capacity of each preload arc is equal to the number of students in the represented preload class.

Phase Training. These arcs represent the actual training in the flight training process. In UPT, a class starts every week excepting two weeks during the Christmas Season. The time and capacity to train in UPT are affected by seasonal changes, if nothing else. A full explanation of how these are calculated will be given in a later section. These parameters are also affected by other factors ranging from a modest change in the aircraft inventory to a complete cessation of a phase of training. The minimum capacity may be used to set a minimum number of students required in each class. In the schema presented in Figure 3.3, flight students enter at the left, matriculate through the flight training program to the right and finally are designated a Naval Aviator or lost due to attrition of one kind or another.

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* The minus one reflects the convention that no onboard student has the full number of weeks-to-go in completing the phase. The full number of weeks are required by any students in a pool awaiting entry into the phase.

Postload of Onboard Students. For the input schedule developed by the DSFM to be accurate, the network must exist such that all students entering the system during the time period of interest graduate within the time period modeled. Considering that the time period of interest begins sometime during the first year modeled, that five years are modeled, and that the longest training path is on the order of one year, the DSFM can model that portion of the first year following the start of the time period of interest through the next three years. In normal use, the DSFM has been called upon to model three years including the year that begins the time period of interest.

PTR. These arcs are normally set to the PTR for each year; but they may be set for a time interval as small as a week. This could be useful in determining the effect on training throughput of different policies on expected output, e.g., level monthly outputs. To represent a required PTR for any time interval, the min/max capacity of a PTR arc is set equal to the appropriate PTR. Alternatively, the PTR arc maximum capacity could be set to infinity with the minimum capacity at zero and the resulting flow solution would represent the maximum throughput of the training system. The time length of a PTR arc is zero.

Student Pools. Student pools are defined as those students available to start a particular phase of training in which there is not room and, as a consequence, must be held over for a class beginning one or more weeks later. Pool arcs permit a student who has completed a phase to wait week by week until there is an opening in the next phase. Since the algorithm used in the DSFM seeks the maximum student flow with the minimum time to train, pooling is shunned except in instances where increased total feasible flow will result. Referring again to Figure 3.3, the actual training activities are viewed as moving from left to right and down with time, then the pool arcs are decending vertical arcs since no training is taking place. Normally, the maximum pool capacity is set at infinity and the minimum pool capacity to zero, allowing for unlimited pooling. The time length is one week.

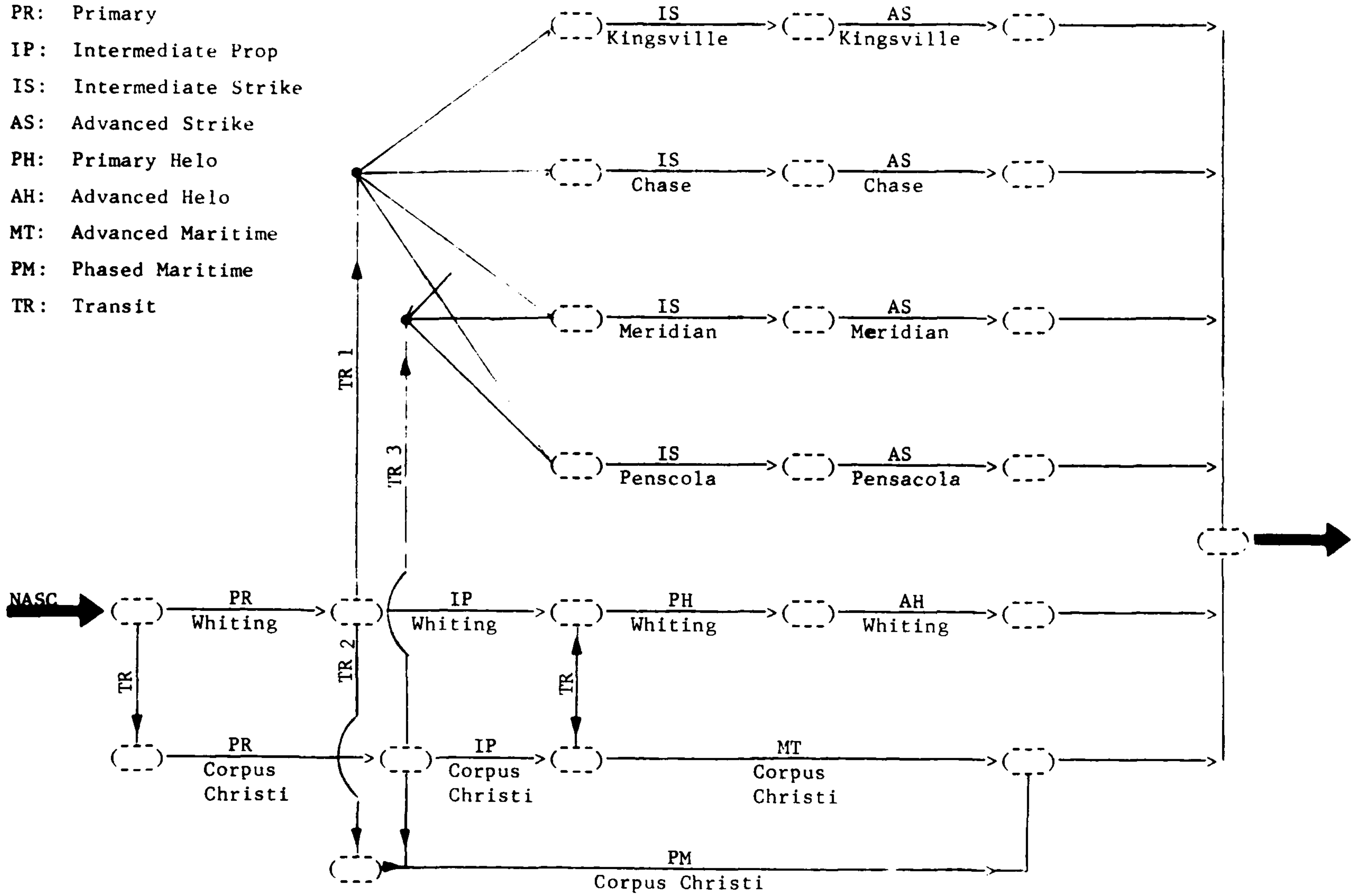
Transits. These arcs are sometimes necessary to represent a nominal transit time in weeks between phases where there is a significant geographical separation. As in the pool arcs, transit arcs are vertical since no training is being conducted. The min/max capacities are zero and infinite, respectively.

The specific DSFM input descriptions will be addressed at this time in the following order.

3.2.1 Networks. The initial step in setting up a DSFM problem is the sketching of the network representing the segment of flight training which is being examined. In practice, the real operational network does not change much over time but networks representing different scenarios in hypothetical situations may be quite varied. It is sound practice to have a network library system which uniquely identifies each network that is structually different from all others. Several runs may be made with the same network and each of these runs should have a distinct run ID assigned to it to distinguish one from another yet all runs should be associated with the same network ID. Networks are sketched in their static form showing as a minimum all admissible phase training arcs together with their names and all transit arcs. The direction of student flow must also be indicated. The focal point of this exposition on input preparation is the UPT program without the NASC which is treated separately. The jet, prop and helo FRSs are also treated but to a lesser degree than UPT.

a. UPT. A network delineating the existing geographical distribution of the UPT program is given in Figure 3.4a with a companion descriptive listing of the phases and their locations in Figure 3.4b. A network of even more detailed configuration could be structured for the DSFM, e.g., a network including individual training squadrons, but the urge to include all relevant detail should be tempered by considerations for responsiveness and economy in data processing

PR: Primary
IP: Intermediate Prop
IS: Intermediate Strike
AS: Advanced Strike
PH: Primary Helo
AH: Advanced Helo
MT: Advanced Maritime
PM: Phased Maritime
TR: Transit



Geographical UPT Network

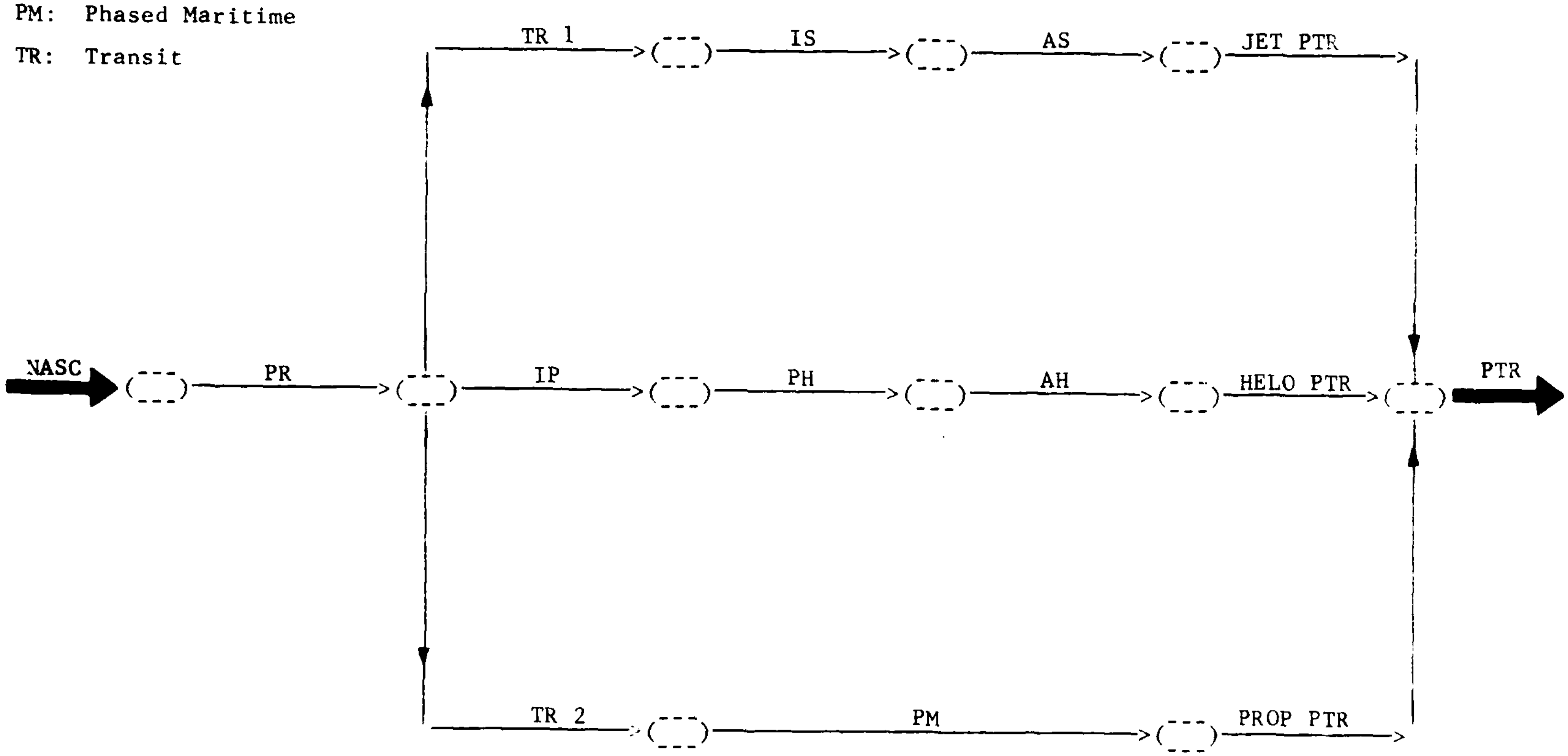
Figure 3.4a

Phase ID	Phase Name	Naval Air Station	Remarks
NASC	Naval Aviation Schools Command	Pensacola FL	This is a ground school to indoctrinate prospective flight school students. There is a separate course for officers (APFI) and for officer candidates (AOCS); the latter course being eight weeks longer.
APFI	Aviation Preflight Indoctrination		
AOCS	Aviation Officer Candidate School		
PR	Primary	Whiting FL Corpus Christi TX	The initial phase of flight training. A screening process prepatory to being assigned to pipeline training.
IP	Intermediate Maritime/Helo	Whiting FL Corpus Christi TX	An intermediate phase in propellor driven aircraft prepatory to entering the advanced prop phase or primary helo phase.
IS	Intermediate Strike	Kingsville TX Chase TX (Beeville) Meridian MS Pensacola FL	The basic jet training phase.
AS	Advanced Strike	Same as IS	The advanced and final phase of jet UPT.
MT	Advanced Maritime	Corpus Christi TX	The advanced and final phase of prop UPT.
PM	Phased Maritime	Corpus Christi TX	This is a combination of IP and MT using the advanced multi-engine prop training aircraft.
PH	Primary Helo	Whiting FL	The initial phase of rotary wing training.
AH	Advanced Helo	Whiting FL	The advanced and final phase of rotary wing UPT.
SERE	Survival, Evasion, Resistance & Escape	Brunswick, ME San Diego CA	"Survival" School is usually conducted enroute from UPT to the Fleet Readiness Squadron.
FRS	Fleet Readiness Squadron	Various East & West Coast Locations	Transition training in the type aircraft to be flown in a fleet squadron. Often referred to as an 'RS'.

Training Phase Abbreviations

Figure 3.4b

PR: Primary
IP: Intermediate Prop
IS: Intermediate Strike
AS: Advanced Strike
PH: Primary Helo
AH: Advanced Helo
PM: Phased Maritime
TR: Transit



Basic UPT Network

Figure 3.5

times. In practice, the simpler network in Figure 3.5 has served adequately for many purposes. Here we have assumed that all phase training of the same kind is conducted in the same place, vis a vis, Figure 3.4. When certain essential arcs are added to the network in Figure 3.5, it becomes the network in Figure 3.6. Static node names (letters of the alphabet) have been added also. This expanded network may evoke some questions which will not be addressed at this point because, in the interests of an orderly exposition of DSFM inputs, these matters are more logically taken in turn at a later time. The network is introduced now so that it may be referenced in the relevant discussions to follow. Indeed, unless otherwise stated, all future references to a UPT network are intended to be to the network in Figure 3.6.

b. NASC. A network in a recent application of the DSFM is shown in Figure 3.7. This network was used for calculating the SNA inputs into NASC thence into the Primary flight training phase.

c. FRS. Figure 3.8, 3.9 and 3.10 provide the current networks for the FRSs in the jet, prop and helo pipelines, respectively. The abbreviation SERGRAD stands for Selectively Retained Graduates from the UPT program. The SERGRAD is retained to become an Instructor Pilot (IP) in the UPT program before being assigned to the fleet. SERE stands for Survival, Evasion, Resistance and Escape. The arcs representing the different Fleet Readiness Squadrons have above the line first the squadron's unique designator and then the type aircraft flown. Below the line is the geopgrahic location of the squadron.

3.2.2 Start Time. The DSFM Start Time is the week and year that the DSFM problem is initiated. It has no fixed relationship to real or calendar time. For routine updating of the DSFM projections, the Start Time is normally the latest time for which the state of the system is known or can be assumed, i.e., all of the data to be described below. For contingency planning involving hypothetical situations, the Start Time may be past, present or future.

3.2.3 Time Period of Interest. The Time Period of Interest (TPOI) is the number of years, including the year of the Start Time, expected to be contained in the DSFM projections. This is normally set at three years or less. Caution: As currently constructed, the DSFM runs internally for a five-year period and five-year projections may be specified; however, the DSFM assumes that all training is terminated at the end of the five years. Output reports which relate to onboard student loads will be affected in the fifth year and to a minor extent in the fourth year. Most of the popular output on production data

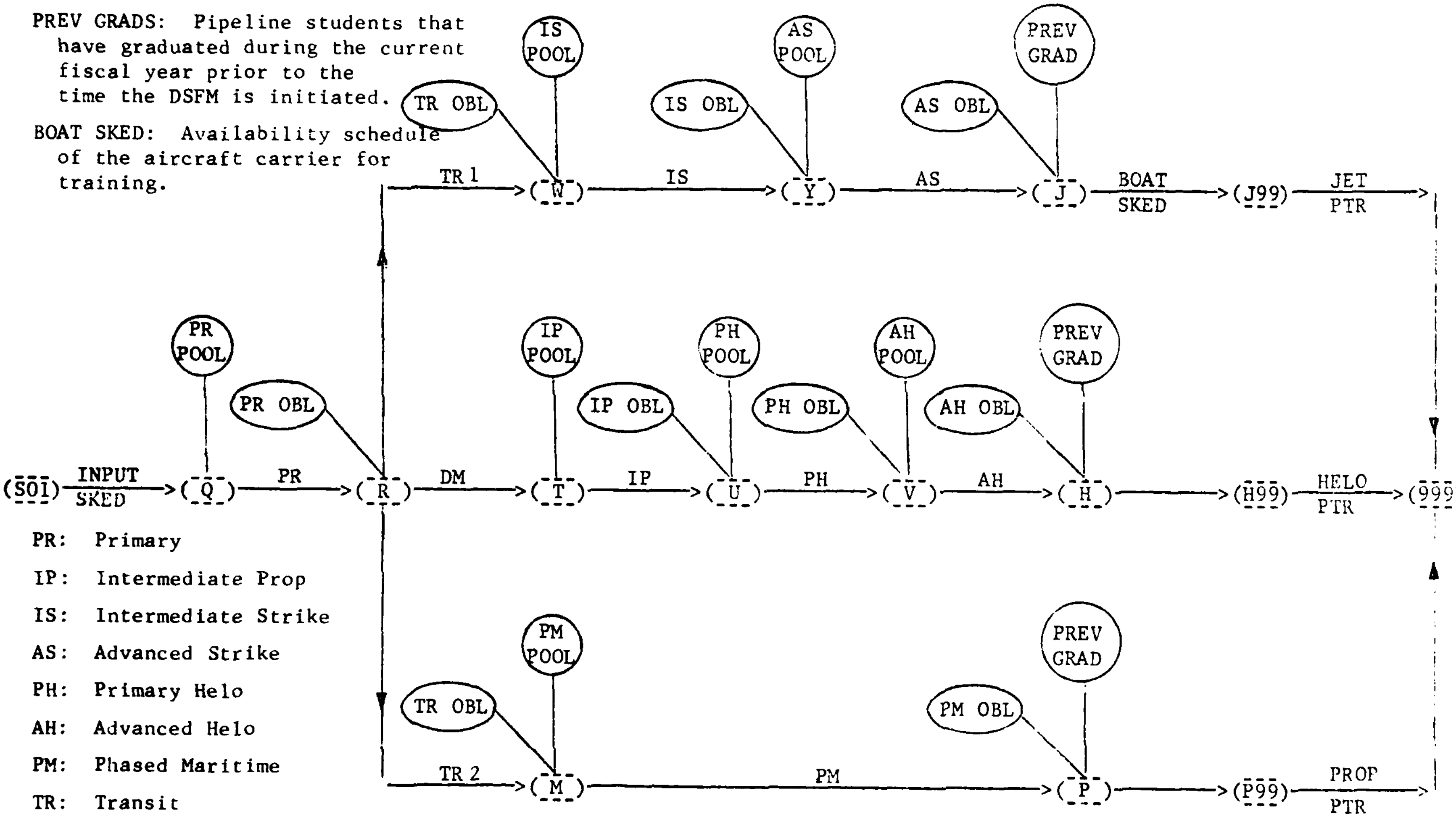
INPUT SKED: Any known schedule for student inputs into the Primary phase of flight training.

POOL: Students waiting to enter the next phase at the time the DSFM is initiated.

OBL: The onboard load of students in a phase (the PRELOAD) at the time the DSFM is initiated.

PREV GRADS: Pipeline students that have graduated during the current fiscal year prior to the time the DSFM is initiated.

BOAT SKED: Availability schedule of the aircraft carrier for training.



PR: Primary

IP: Intermediate Prop

IS: Intermediate Strike

AS: Advanced Strike

PH: Primary Helo

AH: Advanced Helo

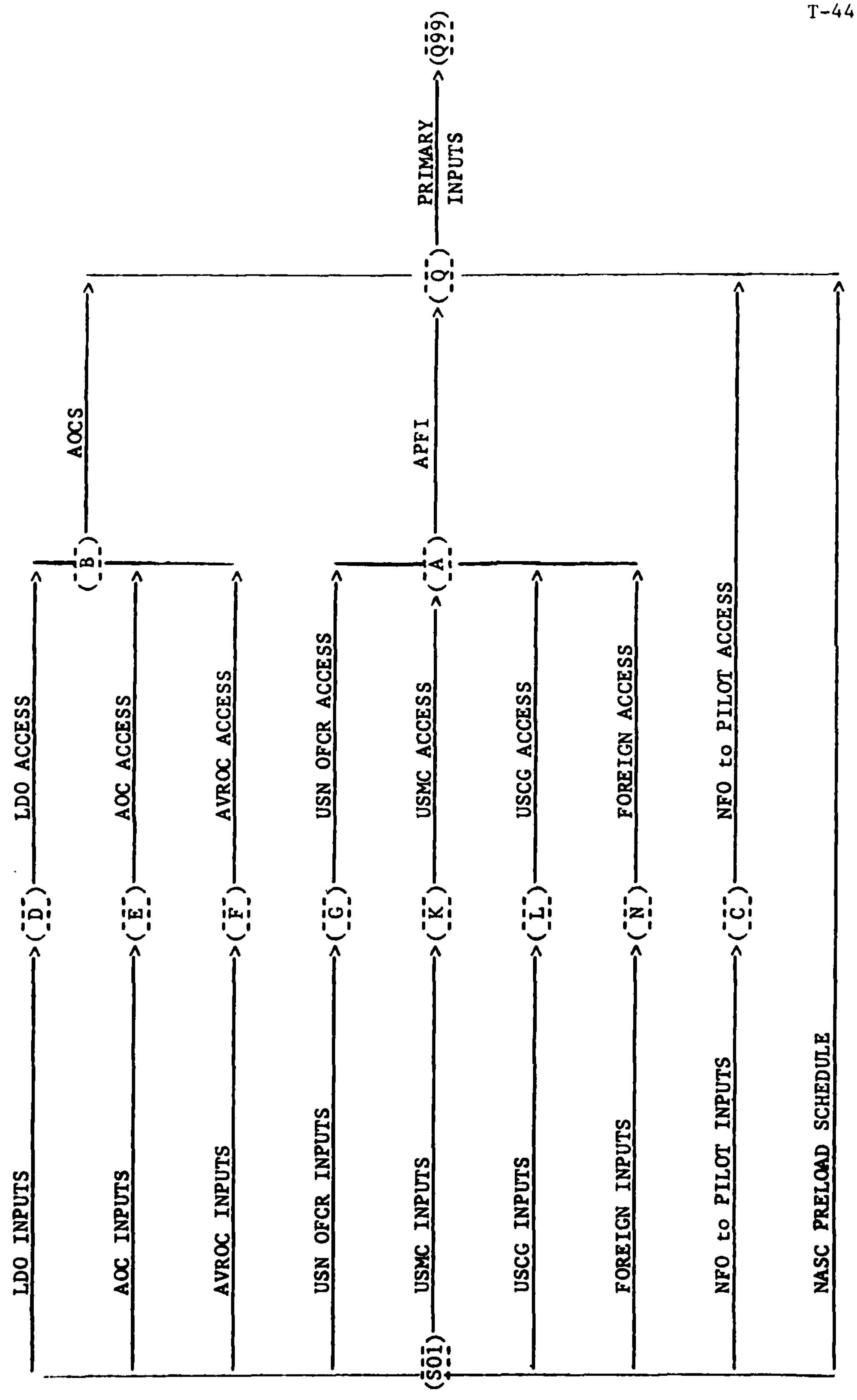
PM: Phased Maritime

TR: Transit

DM: Dummy

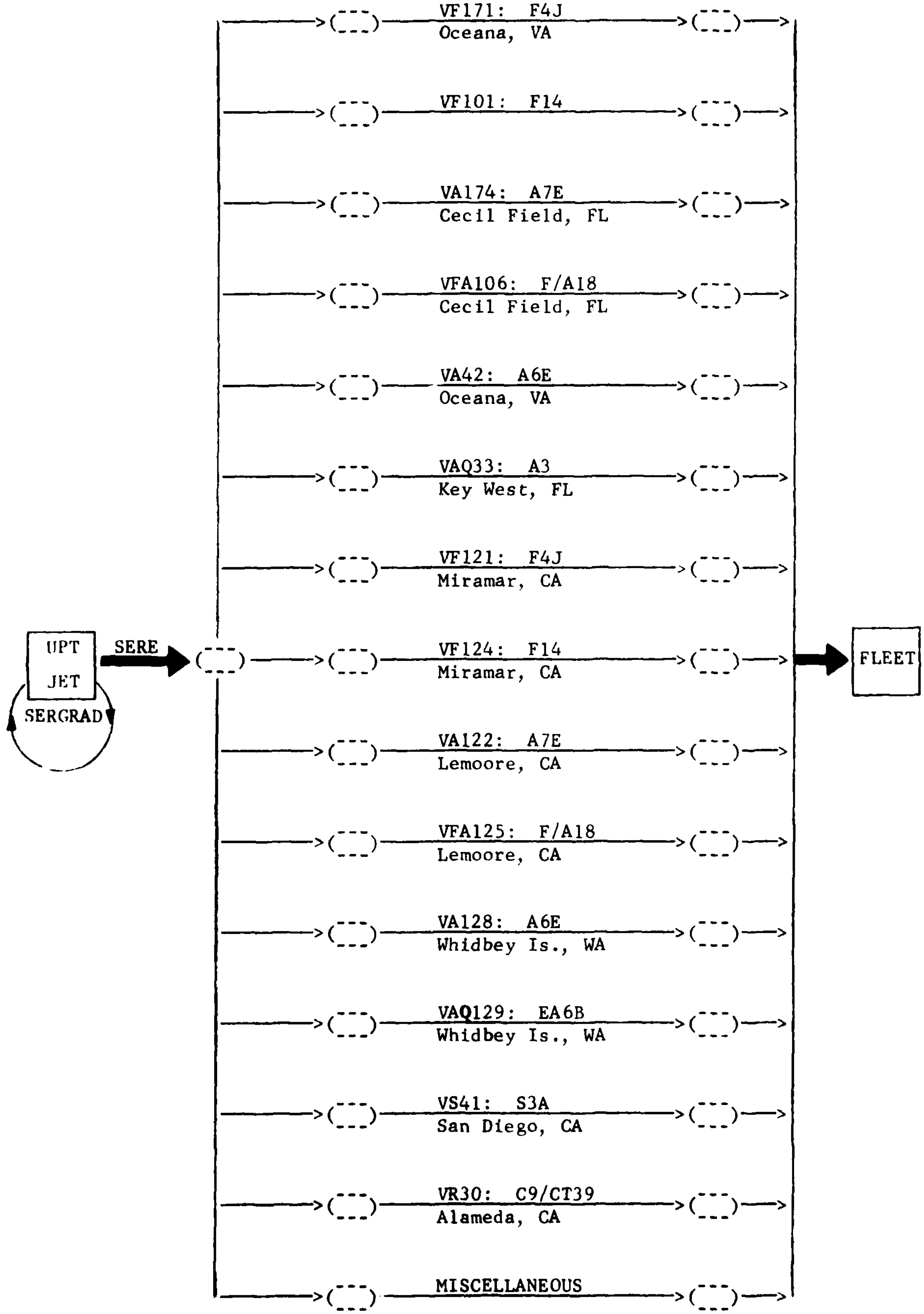
Internal Representation of the Basic UPT Network

Figure 3.6



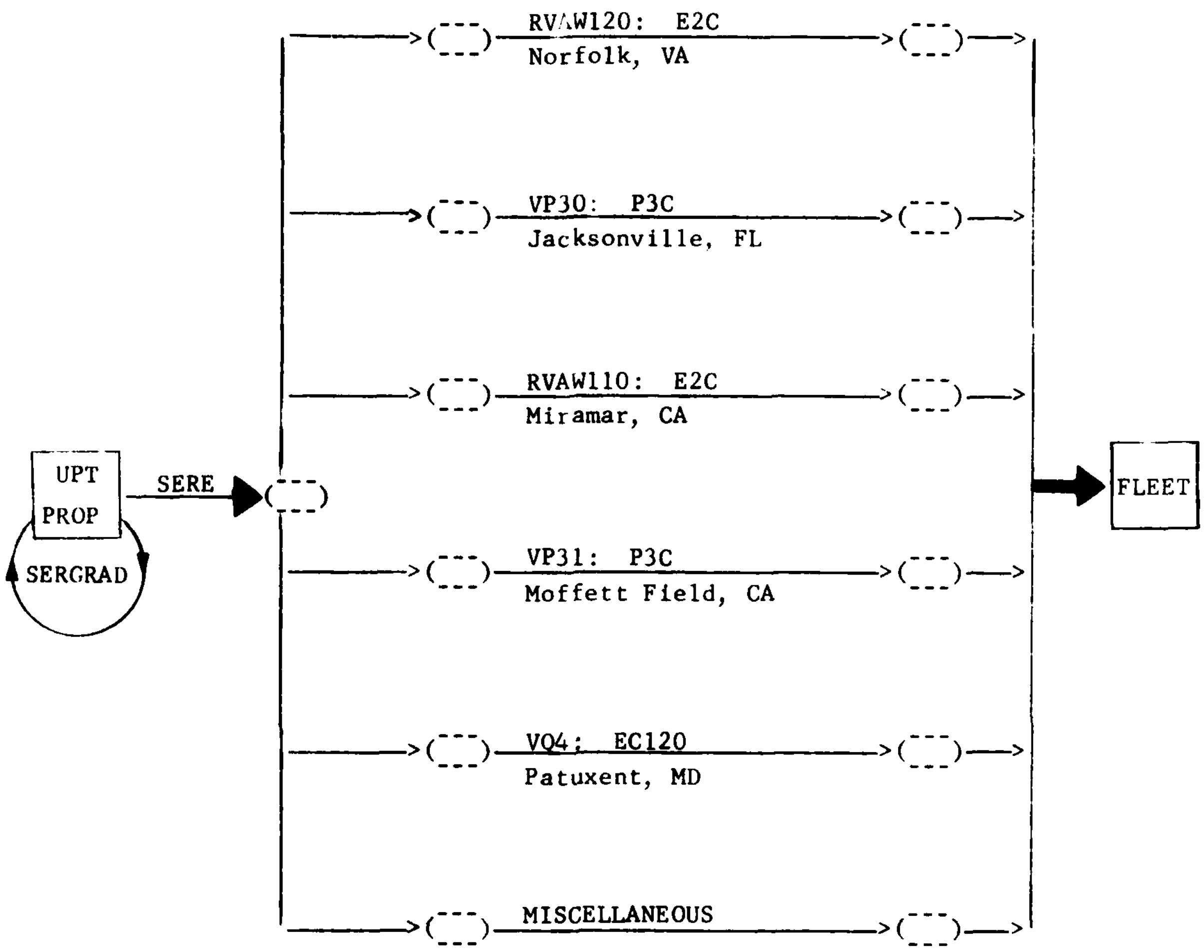
NASC NETWORK

Figure 3.7



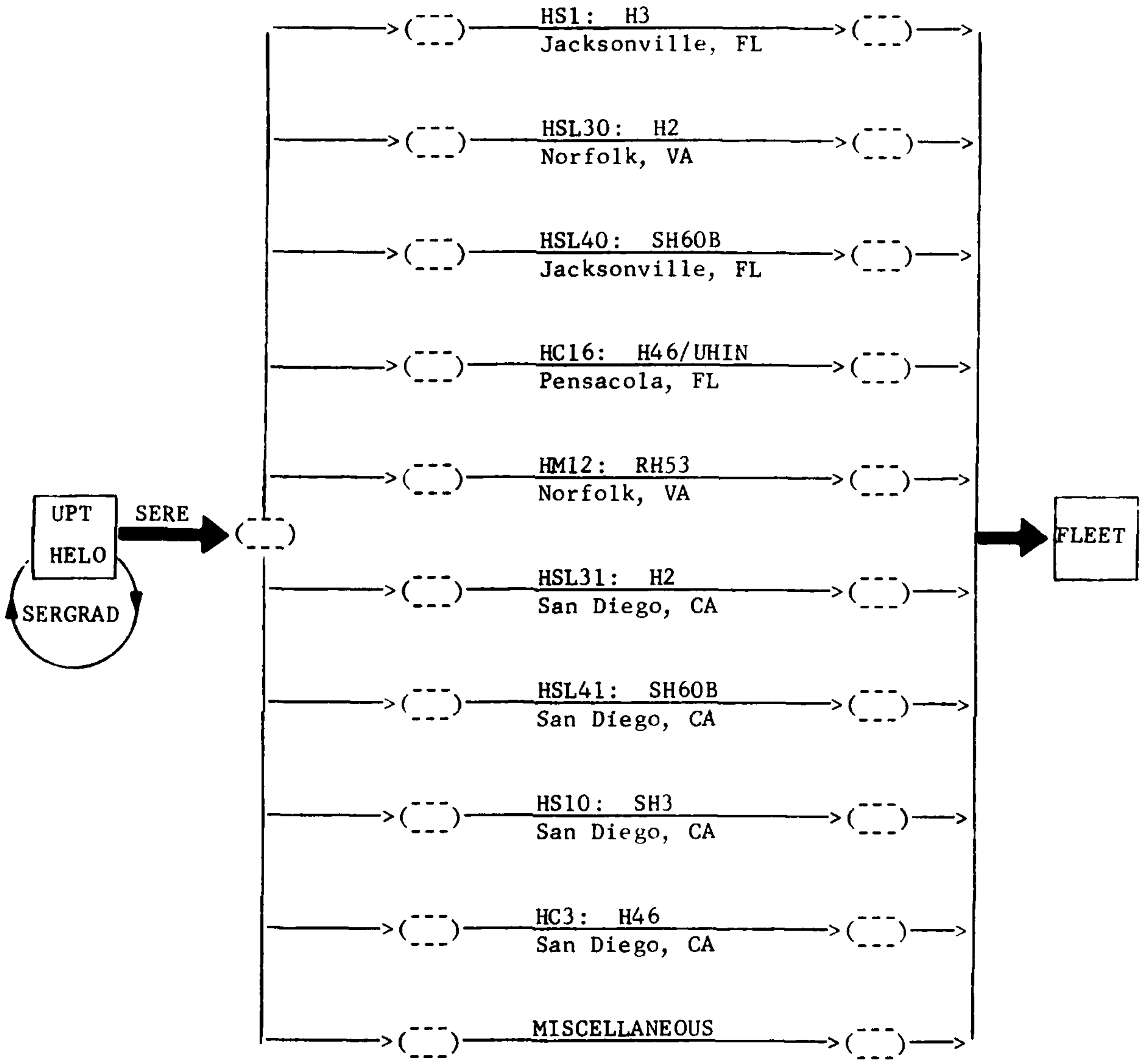
JET-FRS-NETWORK

Figure 3.8



PROP—FRS-NETWORK

Figure 3.9



<u>HELO-FRS-NETWORK</u>

Figure 3.10

such as PTRs are not affected though and the five-year projections can be quite useful as long as this caveat is understood.

3.2.4 Daylight Hours. For flight scheduling purposes, daylight hours are considered to begin one-half hour after sunrise and end one-half hour before sunset. A table of flight scheduling daylight hours by month is given in Figure 3.11. The training bases are all fairly close to the 30th parallel so one table is approximately correct for all locations.

3.2.5 Weather. Weather data are collected and retained by CNATRA for each training base, each squadron at the base and each type aircraft flown by the squadron. These data are reported monthly in the ASR and running averages over five years or more are calculated by the CNATRA staff. Figure 3.12 is an example of the running averages. These data reduce to the table in Figure 3.13 for the network in Figure 3.5.

The percent of scheduled flights that can be expected to be flyable as far as the effects of weather are concerned is considered to be the percentage of flyable weather. Data are collected according to the following equation.

$$WX\% = 100[(\text{Scheduled flights} - \text{Flights lost to WX})/\text{Scheduled flights}]$$

Notice that scheduled flights lost to lack of aircraft, students, instructors, etc., are not a function of the weather factor. Also, note this is not just a pure meteorological factor - the type training and mission play a role.

3.2.6 Time to Train. This is the planned average scheduled weeks for a student to complete a phase of training. This is the average total time in the squadron and includes the total flight and simulator syllabi, ground school and any other formal schools under the purview of the particular squadron. In our example, the latest available values are the following planning factors.

Phase		Time to Train
PR:	Primary	20 weeks
IP:	Intermediate Prop	5
IS:	Intermediate Strike	22
AS:	Advanced Strike	18
PH:	Primary Helo	5
AH:	Advanced Helo	11
PM:	Phased Maritime	20
TR1:	Transit PR to IS	2
TR2:	Transit PR to PM	2

DAYLIGHT FLYING HOURS

MONTH	SUNRISE	SUNSET	DAYLIGHT HOURS/DAY MINUS ONE
OCT	0601	1729	10.5
NOV	0625	1704	9.7
DEC	0648	1702	9.2
JAN	0657	1722	9.4
FEB	0641	1748	10.1
MAR	0610	1808	11.0
APR	0533	1828	11.9
MAY	0506	1847	12.7
JUN	0458	1902	13.1
JUL	0509	1902	12.9
AUG	0527	1841	12.3
SEP	0544	1805	11.4
			11.2 average

Reference: Sunrise and sunset times were taken from a 1976 World Almanac for the 15th of each month at 30° north latitude.

Note: The daylight flying day is defined as beginning one-half hour after sunrise and ending one-half hour before sunset. Further, normal operations are based on a five-day week, 50-week training year and 240 scheduled days per year.

Figure 3.11

CNATRA WEATHER FACTORS WLW:11/26/79

LOCATION & PHASE	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVE.
WHITING FIELD													
PR & IP	.872	.695	.784	.593	.716	.679	.742	.771	.842	.700	.789	.728	.743
PH	.907	.777	.850	.724	.799	.789	.849	.869	.951	.803	.896	.868	.840
AH	.917	.849	.860	.697	.819	.803	.858	.903	.956	.848	.927	.906	.862
CORPUS CHRISTI													
PR & IP	.829	.751	.696	.544	.631	.592	.622	.642	.837	.916	.876	.768	.721
MT	.949	.930	.919	.796	.852	.896	.919	.922	.964	.977	.966	.907	.917
KINGSVILLE													
IS	.914	.887	.860	.757	.866	.866	.876	.876	.929	.954	.917	.887	.882
AS	.912	.928	.852	.796	.878	.823	.838	.825	.925	.960	.928	.904	.881
CHASE													
IS	.894	.874	.831	.731	.818	.835	.848	.825	.935	.949	.915	.875	.860
AS	.922	.901	.859	.796	.849	.856	.857	.868	.938	.952	.939	.909	.833
MERIDIAN													
IS	.865	.834	.860	.721	.811	.789	.812	.830	.898	.821	.873	.815	.828
AS	.890	[illegible]	.841	.688	.788	.764	.799	.789	.875	.798	.865	.814	.812
PENSACOLA													
IS	.913	.873	.912	.748	.834	.795	.823	.856	.933	.807	.907	.864	.854
AS	.924	.853	.913	.842	.842	.787	.823	.846	.956	.840	.889	.899	.867

PR: PRIMARY
IP: INTERMEDIATE MARITIME/HELO
PH: PRIMARY HELO
AH: ADVANCED HELO

MT: ADVANCED MARITIME
IS: INTERMEDIATE STRIKE
AS: ADVANCED STRIKE

DATA BASE: OCT 1974 through SEP 1979
CNATRA (N-21) 6 NOV 1979

Figure 3.12

WEATHER FACTORS

PHASE	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVE.
PR: Primary and IP: Inter. Prop/Helo	.864	.706	.766	.583	.698	.661	.718	.745	.841	.743	.806	.736	.738
IS: Inter. Strike	.891	.865	.850	.736	.832	.830	.845	.844	.921	.908	.902	.859	.857
AS: Adv. Strike	.908	.883	.851	.760	.838	.814	.831	.827	.913	.903	.911	.876	.860
MT: Adv. Maritime or PM: Phased Maritime	.949	.930	.919	.796	.852	.896	.919	.922	.964	.977	.966	.907	.917
PH: Primary Helo	.907	.777	.850	.724	.799	.789	.849	.869	.951	.803	.896	.868	.840
AH: Advanced Helo	.917	.849	.860	.697	.819	.803	.858	.903	.956	.848	.927	.906	.862

Figure 3.13

Caution: Time to Train is given only in integer values to the DSFM. Normally, planning factors are also integer valued although occasionally they may go to one decimal place in which case they must be rounded off. Also the average time to train must hold for the entire five-year period; however, in practice this is no real constraint. If the average time to train is altered during the five-year period, the capacity to train (described later) can be set to zero and another arc previously set to a zero capacity can introduce the new appropriate average time to train at the correct time interval. This may be necessary when there is a syllabus change, a base closure or some other cause.

Given this average time to train, the weekly variations due to seasonal changes in the weather and daylight hours will be automatically calculated by the DSFM program. This weekly time to train is defined as the time in weeks that a student could expect to spend in completing the phase if he enters the phase at the beginning of that particular week.

Since the weeks-to-train parameter is automatically computed, an explicit description of how these computations are made is in order; but, first, a few words about the rationale underlying the calculations. It can be noted from historical data that, for a phase involving flight training, winter classes are, in general, longer than summer classes. It can also be noted that available daylight flyable hours (daylight hours times weather factor) are less in the winter than in the summer. Since most UPT phases are predominately daylight flight training, the inverse relationship between available daylight flyable hours and class length is taken to be a cause and effect relationship. The basic assumption is that total number of required daylight flyable hours remains constant for the completion of each class without regard to the time of the year; this assumption being consistent with the fact that winter classes are longer than summer classes.

The relevant planning factors are:

L	Annual average class length in weeks
H_{ij}	Daylight hours on day i of the jth week
W_{ij}	Weather factor on day i of the jth week
D_{ij}	Work day factor(1 -> workday, 0 -> non-workday))

The flyable hours during the jth week are then:

$$F_j = \sum_{i=1}^{7} D_{ij} W_{ij} H_{ij} .$$

The annual average flyable hours per training week, F, may be calculated based on 50 training weeks per year (two weeks off at Christmas):

$$F = \sum_{j=1}^{52} F_j/50 \ .$$

Therefore, the average flyable hours available to the average class of length L is F x L and it is this value that is used to determine the length of a particular class.

The sum of the flyable hours available to a class of length n-weeks staring in week j is:

$$F_j^n = \sum_{k=j}^{j+n-1} F_k \ .$$

To find the length, L_j , of the jth class, the minimum integer n is sought that satisfies:

$$\text{Min} \quad n \,\middle|\, F_j^n \geq FL \ .$$

Then,

$$L_j = \begin{cases} n, \text{ if } (F_j^n - FL)/(F_j^n - F_j^{n-1}) \leq .5 \ , \\ n-1, \text{ otherwise.} \end{cases}$$

3.2.7 Annual Pilot Training Rates. The Pilot Training Rates (PTRs) are published by the Aviation Manpower and Training Division (Op-59) of the Office of the Chief of Naval Operations. They are published at least annually and more often as changes occur. The PTR establishes not only the annual total rate but also the breakdown by Navy/Marine/Coast Guard/Foreign and by pipeline -- Jet/Prop/Helo. To this we have added the five-year totals and percentages by pipeline as shown in Figure 3.14. These percentages are a factor in calculating postphase attritions and the allocation of the same type of aircraft among phases.

3.2.8 Postphase Attrition. The inphase attrition, A, is the expected percentage of students commencing a phase who will not successfully complete the phase for any reason (flight failure, own request, physical, fatalities, etc.). The table below contains the inphase attritions currently used in the UPT DSFM.

PILOT TRAINING RATE (PTR)
FY79-83

	JET	PROP	HELO	TOTALS
FY79				
NAVY	375	295	215	885
MARINE	165	0	305	470
CG&F	30	47	54	131
TOTALS	570	342	574	1,486
FY80				
NAVY	318	316	251	885
MARINE	158	0	292	450
CG&F	30	47	54	131
TOTALS	506	363	597	1,466
FY81				
NAVY	324	322	254	900
MARINE	188	0	282	470
CG&F	30	47	54	131
TOTALS	542	369	590	1,501
FY82				
NAVY	342	340	268	950
MARINE	188	0	282	470
CG&F	30	47	54	131
TOTALS	560	387	604	1,551
FY83				
NAVY	342	332	276	950
MARINE	188	0	282	470
CG&F	30	47	54	131
TOTALS	560	379	612	1,551
5-YR TOTAL	2,738	1,840	2,977	7,555
5-YR PERCENTAGES	36.2%	24.4%	39.4%	100%

Note: PTR for FY84 same as for FY83.

Figure 3.14

Phase	Attrition
PR	16
IP	2
IS	8
AS	4
PH	2
AH	4
PM	4

The postphase attrition, A^+, represents the percentages of expected losses in the number of phase graduates before final graduation from UPT. The projected PTRs and the proportionate share of the total by each of the three pipelines figure into the calculations of some of the postphase attritions. The proportion of each pipeline would not matter if it were not for the sharing of phases such as Primary (PR). By convention, we will designate the prephase attrition as ^+A. The definition is the same as for A^+ except that 'phase entrants' replaces 'phase graduates.'

Figure 3.15 is one way of presenting the postphase attrition and related data. The upper number in the boxes is the number of students entering the phase to produce 100 pipeline grads. The lower number is the prephase attrition. The computations are carried out from right to left in the figure. The number of entrants, E , to any phase to produce 100 pipeline grads is equal to:

$$E = 100/(1-A)(1-A^+) ,$$

and the prephase attrition:

$$^+A = 100(E-100)/E .$$

For example, the JET pipeline would be calculated as follows:

$$E \text{ to AS} = 100/.960 = 104.2, \text{ and}$$
$$^+A \text{ to AS} = 4.2/104.2 = 4.0\%$$

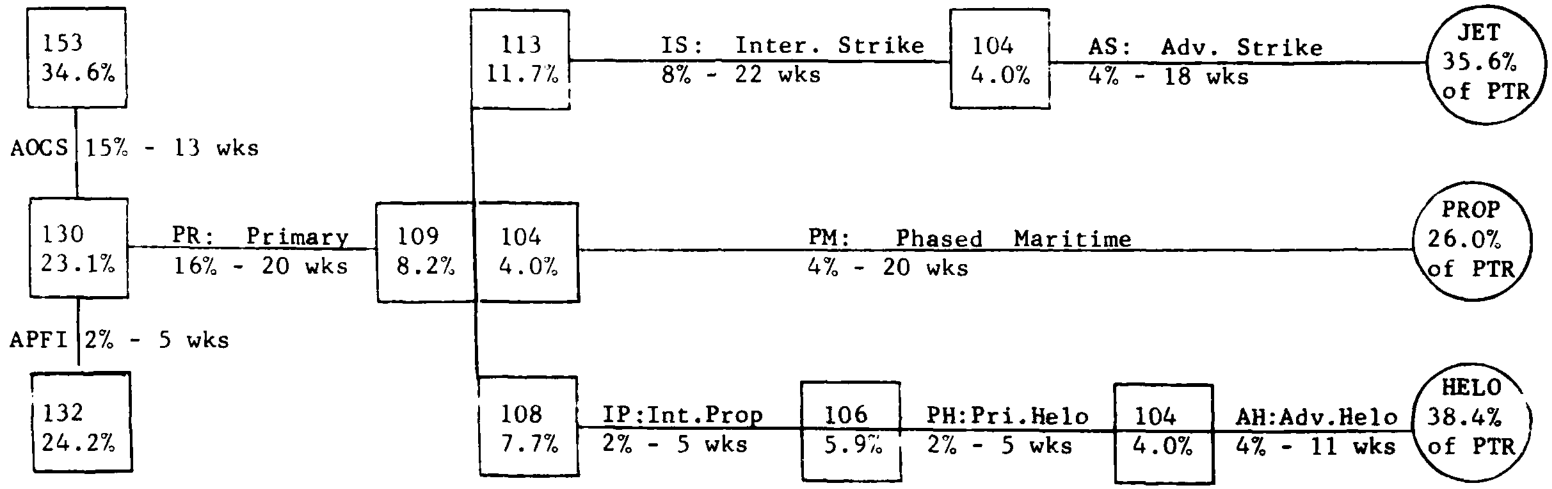
^+A to AS is A^+ from IS, therefore:

$$E \text{ to IS} = 100/(.920)(.960) = 113.2, \text{ and}$$
$$^+A \text{ to IS} = 13.1/113.2 = 11.7\%$$

And

$$E \text{ to PR} = 100/(.840)(.883) = 134.8 , \text{ and}$$
$$^+A \text{ to PR} = 34.8/134.8 = 25.8\%$$

Note: Values shown for PR are for the JET pipeline only.



A ---------> Number of entrants at this point to produce 100 pipeline grads with given PTR percentages.
B ---------> Pipeline attrition suffered by entrants at this point in the pipeline.

Number of PR entrants for 100 pipeline grads		PR entrants pipeline attrition		% of PR entrants to achieve PTR balance	
JET:	135	JET:	25.9%	JET:	37.1%
PROP:	124	PROP:	19.4%	PROP:	24.8%
HELO:	129	HELO:	22.5%	HELO:	38.1%

POSTPHASE ATTR TIONS

Figure 3.15

In Figure 3.15, the output of PR branches into the three pipelines: JET, PROP & HELO. The numbers to the right of the vertical line connecting PR to IS, PM and IP are pipeline peculiar; the numbers to the left of the vertical are weighted for the PTR percentages and are to be used when the pipeline assignments are not known. The lefthand numbers are calculated as follows:

	%PTR		E		
JET	35.6	x	113	=	40.2
PROP	26.0	x	104	=	27.0
HELO	38.4	x	108	=	41.5

					108.7 students

Similarly:

	%PTR		+A		
JET	35.6	x	11.7	=	4.2
PROP	26.0	x	4.0	=	1.0
HELO	38.4	x	7.7	=	3.0

					8.2%

The number of students, E , to enter PR is:

JET	113/.84	=	135
PROP	104/.84	=	124
HELO	108/.84	=	129

The prephase attrition, +A , into PR is the pipeline loss divided by the number of pipeline entrants:

JET	35/135	=	25.9%
PROP	24/124	=	19.4%
HELO	29/129	=	22.5%

The percentage of all entrants into PR to achieve the right balance in the pipeline PTRs is:

	Pipeline E-->PR		%PTR		
JET	135	x	35.6	=	48.1
PROP	124	x	26.0	=	32.2
HELO	129	x	39.8	=	49.5

			Total:		129.8 students

	Weighted Average		
JET	48.1/129.8	=	37.1%
PROP	32.2/129.8	=	24.8%
HELO	49.5/129.8	=	38.1%
			100.0%

3.2.9 Student Onboard Load. The onboard load (OBL) of students in each squadron and each phase within a squadron can be obtained from the monthly Aviation Statistical Report (ASR). The number of students in transit is not explicitly reported so this parameter is estimated to be the number of transit weeks times the weekly capacity to train for the next phase of training. In our example, the (OBL)s for the first week of FY81 are given in the following table.

Phase	(OBL)	$(OBL)^+$
PR	597	500
IP	66	63
IS	327	301
AS	198	194
PH	66	65
AH	133	130
PM	180	176
TR1	24	21
TR2	18	17

The $(OBL)^+$ column is the (OBL) reduced for the inphase and postphase attritions, i.e. the expected number of pipeline graduates. Unless there is information to the contrary, we may assume that the onboard students are uniformly distributed in the weeks to go in the phase and also in the likelihood of being attrited. A consequence of this is that one-half of the inphase attrition, A , has already taken place. That is, the original number of entrants into the phase of those now in the phase (OBL) is closely approximated by (OBL)/(1-A/2). The number of entrants then suffer an attrition equal to A so the number exposed to the postphase attrition, A^+ , is

$$[(OBL)/(1-A/2)](1-A) .$$

Therefore,

$$(OBL)^+ = [(OBL)/(1-A/2)](1-^+A) .$$

There is no inphase attrition for the transit arcs, only postphase attrition. For TR1 (JET) this is 11.7% and for TR2 (PROP) it is 4.0%.

The UPT system is roughly a year in length and, as such, about one year's input of students are in the system at any point in time. The current state of the system for purposes of starting up the DSFM is accounted for by preloading the network with a flow representing the students in the system at the beginning of the time period of interest.

If the best estimate of the distribution of onboard students is that they are evenly distributed with respect to weeks to go in phase, then the DSFM will automatically calculate this distribution. The DSFM considers the phase length in weeks for that particular time of the year and divides the number of students on board by that number of weeks minus one. The minus one reflects the convention that no onboard student at DSFM start time has the full number of weeks to go in completing the phase. The full number of weeks are required by any students in a pool awaiting entry into the phase.

If there is reason to believe that the onboard students are not uniformly distributed in the weeks to go in phase, then the actual or estimated distribution can be manually entered.

3.2.10 Student Pools. Pools are defined as those students available to start a particular phase or phases* of training for which there is no room in the next class and, as a consequence, must be held over for a class beginning one or more weeks later when there is room. Since the algorithm used in the DSFM seeks to maximize student flow with the minimum time to train, pooling is shunned except in instances where increased total feasible flow will result.

The number of students in a pool awaiting phase training are contained in the monthly ASR. To represent pipeline graduates these numbers must be reduced by ^{+}A for the upcoming phase or by A^{+} for the just-completed phase when it is optional which of several phases may be taken next. Usually it is best not to allow the DSFM to form pools at a node in the network which is connected directly to two or more training phases. Refer to Figure 3.6. Here we have inserted the 'dummy' arc R to T so that pools will form at T awaiting IP training. Pools are not allowed to form at Node R simply by not constructing the pool arcs in the 'BUILD' phase of the network description. Pools awaiting IS and PM training can form at nodes W and M, respectively, after they have transited to the new training base.

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* It is recognized that students have their pipeline assignments when completing a phase such as PR so they are never waiting to enter more than one phase at any time. The algorithm for generating student flows does not have this information, however, so it assigns students to any available phase as the students become available.

3.2.11 Transits. Transit arcs are sometimes necessary to represent a nominal transit time in weeks between phases where there is a significant geographical separation. When the UPT network is aggregated as in Figure 3.5, the assigned transit times is an average over the different travel times weighted by the different capacities to train at each base. Similar to the time to train parameter transit times must be stated in integer weeks.

3.2.12 Previous Pipeline Grads. When the DSFM Start Time is not at the beginning of a fiscal year, it is essential to some of the DSFM outputs to include the number of pipeline graduates previously graduated during the initial fiscal year of the time period of interest. These are introduced as capacities in the arcs shown in Figure 3.6 as 'PREV GRAD' to nodes J, H and P . No reduction for attrition is applicable here.

3.2.13 Scheduled Student Entries. The input schedule of students into NASC is published annually by an OPNAVNOTE 1542. See Figure 3.16 for a sample of the format. Changes are sometimes made during the year to reflect changing conditions or experience. Infrequently, there are student entries that bypass the standard course at NASC and enter the system at the PR flight training level. The recent NFO to Pilot program is an example. To the extent that the input schedule is known, the inputs are converted in calendar time to PR inputs and in numbers equivalent to the expected pipeline graduates by multiplying the PR inputs by $(1-{}^{+}A)$ for PR. A simple subroutine can convert the NASC inputs to PR inputs by accounting for the class duration and attrition in NASC. Beyond the date date when the student input schedule is known, the capacity of input arcs is normally made very large so that the DSFM can select the optimum input values. The time duration of input arcs is zero.

3.2.14 Capacity to Train. A basic input to the UPT DSFM is the average number of phase graduates per week C , for every phase in the system. This average is based on the maximum production rate to be expected over an entire year for the same operating circumstances. The number need not be used in the DSFM over an entire year but the average weekly production rate must be averaged over a year as though it would be. When this number has been appropriately reduced to pipeline graduates by the postphase attrition, A^{+} , as explained earlier, it is called C^{+} . Given this input parameter, then the weekly variation in the capacity to train for a particular phase is automatically computed by the following relationship.

$$C_j^{+} = C^{+}L/L_j \ .$$

OPNAVNOTE 1542
18 APR 1979

PILOT TRAINING PROGRAM

FY-79 INPUT PLAN
(THIRD AND FOURTH QUARTERS)

CLCVN	CL NO	AOC P WK	AOC P CM	AOC A WK	AOC A CM	AVROC P WK	AVROC P CM	AVROC A WK	AVROC A CM	OFFICER P WK	OFFICER P CM	OFFICER A WK	OFFICER A CM	USMC P WK	USMC P CM	USMC A WK	USMC A CM	USCG P WK	USCG P CM	USCG A WK	USCG A CM	FOREIGN P WK	FOREIGN P CM	FOREIGN A WK	FOREIGN A CM
4/2	24	0	100			10	105			3	378			12	227			0	30			0	0		
4/9	25	15	115			0	105			0	0			10	287			0	30			1	1		
4/16	26	0	0			10	115			1	379			10	297			3	33			0	1		
4/23	27	15	130			0	0			0	379			9	306			0	33			0	1		
4/30	28	0	0			10	125			0	379			9	315			0	33			0	1		
5/7	29	15	145			0	0			1	380			9	324			0	33			0	1		
5/14	30	0	0			5	130			1	381			9	333			0	33			0	1		
5/21	31	10	155			0	130			0	381			9	342			0	33			0	0		
5/28	32	0	0			0	130			0	381			9	351			0	33			0	0		
6/4	33	10	165			0	130			0	381			9	360			0	33			0	0		
6/11	34	0	0			0	130			0	381			9	369			0	33			0	0		
6/18	35	20	185			0	130			0	381			9	378			3	36			0	0		
6/25	36	0	0			0	130			3	384			9	387			0	36			0	0		
7/2	37	20	205			0	130			2	386			9	396			0	36			0	0		
7/9	38	0	0			0	130			0	386			9	405			6	42			0	0		
7/16	39	20	225			0	130			0	386			9	414			0	42			0	0		
7/23	40	0	0			0	130			16	402			9	423			0	42			0	0		
7/30	41	5	230			0	130			14	416			9	432			0	42			0	0		
8/6	42	0	0			0	130			14	430			9	441			0	42			0	0		
8/13	43	5	235			0	130			14	444			9	450			0	42			0	0		
8/20	44	0	0			0	130			10	454			9	459			3	45			4	0		
8/27	45	5	240			0	130			10	464			9	468			0	45			0	0		
9/3	46	0	0			0	130			10	474			9	477			6	51			0	0		
9/10	47	5	245			0	130			15	489			9	486			0	51			0	0		
9/17	48	0	0			0	130			15	504			9	495			0	51			0	0		
9/24	49	5	250			0	130			13	519			9	504			6	57			0	0		
TOTAL			250				130				519				504				57			5			

NOTES:
1. P - Planned Input; A - Actual Input; CM - Cumulative Input; WK - Weekly Input.
2. Planned inputs are based upon FY-80 Pilot Training Rates and consideration of the current student pilot load. OPNAV authorization required for significant input changes.
3. AOC input does not include attrition subsequent to reporting to NAS Pensacola and prior to actual enrollment into Naval Aviation Schools Command.

Figure 3.16

T-447

Enclosure (1)

where C_j^+ is defined as the maximum class size of pipeline graduates to enter at the beginning of the jth week.

Many scenarios call for one or more changes to C^+ for a particular phase. Aircraft inventories change over time Syllabi are modified. When a phase is terminated, the capacities are reduced to zero at the time when no more entries are allowed into the phase. New phases can be initiated by the reverse representation. Unlike L, C^+ can be changed at any week during the time period of interest. Also, the C_j^+ may be individually specified for each week or for some of the weeks. The automatic computation for C_j^+ will be only for those time spans that are specified. See Figure 3.17 for a sample format for specifying either C^+ or C_j^+ . The assigned values for C^+ or C_j^+ need not be integer valued as is the case for L.

a. The method of determining the value of C^+ is independent of the operation of the DSFM. It can be arbitrarily assigned or calculated on the basis of some rationale. One practical method is to base the determination on the planning factors for aircraft utilization and the total flight hours per phase grad as in Figure 3.18. The final column in this tabulation "Pipeline Grads per Aircraft per Year" multiplied by the programmed aircraft inventories (as supported by simulators) in Figure 3.19 will yield values for C shown in Figure 3.20. This method provides a good benchmark, however, if the capacity to train is not constrained by the number of available aircraft, but by maintenance manning levels, number of effective instructors on board, or some other resource, possibly students, then the computation for C should reflect these constraints.

Some aircraft are used in more than one phase. Both the T28 and the T34C are used in the PR and IP phases. For purposes of determining the capacity to train for each of the two phases, it is necessary to allocate the aircraft between the two phases if, indeed, aircraft are the pacing resource on capacity. In practice, the NATRACOM does not have to do the allocation because the same squadrons do both phases of training, at least at present, but with the future VTX aircraft this may not be so. In allocating aircraft of the same type among phases the pipeline percentages of the total PTR again play a part. Consider the following example.

ARC	FROM NODE YZZ	TO NODE YZZ	MAXIMUM CAPACITY "C"	MINIMUM CAPACITY "M"	WEEKS TO TRAIN "L"	ATTRITION % "A"

Figure 3.17

AIRCRAFT PRODUCTIVITY IN PIPELINE GRADS/YEAR

PHASE NAME	TYPE AIRCRAFT	FLIGHT HOURS/ AIRCRAFT/ YEAR	FLIGHT HOURS/ PHASE GRAD	POST-PHASE ATTRI-TION	FLIGHT HOURS/ PIPELINE GRAD	PIPELINE GRADS/ AIRCRAFT/ YEAR
Primary	T34C*	800	109.5	10.1	121.8	6.57
	T34C	800	87.0	10.1	96.8	8.26
	T28	622	86.2	10.1	95.9	6.49
Intermediate Prop/Helo	T34C*	800	38.4	4.9	40.4	19.80
	T34C	800	29.9	4.9	31.4	25.48
	T28	622	29.8	4.9	31.3	19.87
Maritime	T44A#	800	136.0	0.0	136.0	5.88
	T44A	800	108.3	0.0	108.3	7.39
Primary Helo	TH57	643	42.1	5.0	44.3	14.51
Advanced Helo	TH1	578	80.5	0.0	80.5	7.18
Basic Jet	T2C	543	134.0	8.0	145.7	3.73
Advanced Jet	TA4	580	144.7	0.0	144.7	4.01

*without 2B37
#without 2F29

Figure 3.18

AIRCRAFT INVENTORIES

	Type A/C	FY80				FY81				FY82			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Whiting:													
Primary & Intermediate	T34C	152	151	153	161	169	170	169	168	167	166	165	165
	2B37	3	7	10	13	13							
Corpus:													
Primary & Intermediate	T28	94	94	93	93	85	72	62	53	42	29	16	4
Corpus:													
Maritime	T44A	55				54				53			
	2F29	1	2	3	4	4							
Whiting:													
Primary Helo	TH57	27	28										
Advanced Helo	TH1	61											
Kingsville:													
Basic Jet	T2C	44											
Advanced Jet	TA4	49											
Chase:													
Basic Jet	T2C	46											
Advanced Jet	TA4	48											
Meridian:													
Basic Jet	T2C	34											
Advanced Jet	TA4	31											
Pensacola:													
Basic Jet	T2C	15											
Advanced Jet	TA4	13											

Note: Blank entries on a line indicate a repeat of the last value entered on the left.

Figure 3.19

CAPACITIES: PHASE GRADS/WEEK

	Type A/C	FY80 Q1	FY80 Q2	FY80 Q3	FY80 Q4	FY81 Q1	FY81 Q2	FY81 Q3	FY81 Q4	FY82 Q1	FY82 Q2	FY82 Q3	FY82 Q4
Whiting:	T34C												
Primary		164	176	192	220	230	231	230	230	228	226	225	225
Intermediate		107	118	130	143	153	153	153	148				
Corpus:	T28												
Primary		100	100	100	100	91	77	66	57	45	31	17	4
Intermediate		68	68	68	68	60	52	44	36	23	20	12	4
Corpus:	T44A												
Maritime		65	68	71	75	80				78			
Whiting:													
Primary Helo	TH57	78	81										
Advanced Helo	TH1	88											
Kingsville:													
Basic Jet	T2C	33											
Advanced Jet	TA4	39											
Chase:													
Basic Jet	T2C	34											
Advanced Jet	TA4	38											
Meridian:													
Basic Jet	T2C	25											
Advanced Jet	TA4	25											
Pensacola:													
Basic Jet	T2C	11											
Advanced Jet	TA4	10											

Note 1: All capacities are shown in tenths, i.e., 164 --> 16.4 grads/week.

Note 2: Blank entries on a line indicate a repeat of the last value entered on the left.

Figure 3.20

Average Total Aircraft Hours per Phase Graduate

Aircraft	Primary (PR) Phase	Int. Prop (IP) Phase
T28	86.2 hours	29.8 hours
T34C without 2B37	109.5	38.4
T34C with 2B37	87.0	29.9

With reference to Figure 3.15, the postphase attrition chart, it is noted that:

61.9% of the Primary graduates go directly* to the JET or PROP pipelines.

38.1% of the Primary graduates go to the Int. Prop (IP) Phase.

Therefore:

T28

100% of students get 86.2 hours in PR	86.2 hours
38.1% of students get 29.8 hours in IP	11.4

	97.6 ave. hrs. per stud.

86.2/97.6 = 88.3% assigned as PR aircraft

11.4/97.6 = 11.7% assigned as IP aircraft

T34C without 2B37

100% of students get 109.5 hours in PR	109.5 hours
38.1% of students get 38.4 hours in IP	14.6

	124.1 ave. hrs. per stud.

109.5/124.1 = 88.2% assigned as PR aircraft

11.8/124.1 = 11.8% assigned as IP aircraft

---

* This assumes that all PROP pipeline students go through Phased Maritime (PM). This may not be true for some or all may go through Advanced Maritime (MT) which requires the IP phase as well.

T34C with 2B37

100% of students get 87.0 hours in PR	87.0 hours
38.1% of students get 29.9 hours in IP	11.4

	98.4 ave. hrs. per stud.

87.0/98.4 = 88.4% assigned as PR aircraft
11.4/98.4 = 11.6% assigned as IP aircraft

The 2B37, referred to above, is a flight simulator trainer. The availability of sophisticated training devices (OFT and FIT) can have a marked effect on the total training capacity of various phases of the training pipeline. Although flight simulators are not generally considered to be a constraining resource, to some extent they substitute directly for aircraft flight hours in pursuing training objectives. The availability of flight simulators can be very significant to the productivity of the actual aircraft on board since there can be a substantial difference between the aircraft hours required per phase graduate with and without the simulators. Particular care must be exercised in adjusting flight hours per phase graduate to accommodate introduction schedules for new simulators or changes in the syllabus mix of aircraft and simulator flight hours.

When available aircraft are used as the constraining factor on C , the student flow solution can be checked to see if other resources can meet the flow requirements. Standard planning factors and routine empirical data can be used to project the adequacy of:

(1) Instructors
(2) Maintenance personnel
(3) OPTAR funds

Should any of these appear to be inadequate, then an appropriate C should be designated to reflect this and a new DSFM run executed with the more realistic run parameters.

b. In (a) above we discussed only the capacity, C , - the permitted flow. This upper bound on the flow of students through the system usually reflects operational or scheduling limitations. There is, though, the companion flow parameter, M (for minimum), which states the value of a <u>required</u> flow in the arc, i.e., this is the lower bound for a feasible flow. The value for M is

often set at zero, but when it takes on a greater value, it is usually for flow control purposes in contrast to C which is a capacity limitation. To bring this into sharper focus, the typical settings of C and M will be given for the different groups of arcs described in Section 3.2. We will also include the time to train, L, because it is convenient to do so at this time. A discussion of some of the variations on the assignment of C, M and L will be deferred until Section 4 where some advanced techniques for using the DSFM will be addressed.

(1) Scheduled Student Input

C = scheduled input less the NASC attrition and delayed for the weeks spent in NASC classes

M = C

L = 0

(2) Unscheduled Student Inputs

C = 999

M = 0

L = 0

(3) Preload of Onboard Students

C = (OBL)/(L-1)

M = C

L = 1,2,...,L-1

(4) Phase Training

C = Average maximum capacity to train for the current time period

M = 0

L = average time to train for the phase

(5) Postload of Onboard Students

Not necessary to set individual C, M or L as they were set in the Phase Training arcs above

(6) Preload Pools

C = number of students awaiting entry into the phase as reported in the ASR or otherwise

M = C

L = 0

(7) Computed Pools. Throughout the TPOI there are vertical arcs connecting the initial nodes of Phase Training arcs in the DSFM network which accommodate the student's delay from week to week when there is insufficient capacity in a phase for them to start when they arrive. These are called pool arcs. For these arcs:

C = 999

M = 0

L = 1

(8) Buffer Pools. It is often desirable to plan for a precautionary or buffer pool awaiting the PR phase. This is simply to ensure that enough students are available to feed the flight training pipeline so that costly and non-retrievable resources do not lie idle. The number in the pool is arbitrary but it has been set customarily at 75 in which case the arcs connecting the PR class starting times (the vertical holdover arcs) have:

C = 999

M = 75

L = 1

Note. The lower bound, M, is set to 75 only after such time as the Unscheduled Student Inputs (above) are made available to PR.

(9) Transit Arcs

C = 999

M = 0

L = nominal transit time (a constant)

3.2.15 Resource Requirements. Planning factor information acquired from a variety of sources may be applied against data from a standard DSFM student flow solution to calculate the resource requirements projected through the TPOI. Among the standard NATRACOM planning factors are:

a. total aircraft hours per phase grad
b. maintenance personnel per aircraft
c. instructor pilot flight hours per phase grad
d. annual utilization of instructor pilots

Additional sources such as the Navy Resource Model (NARM) [8] and the Visibility and Management of Operating and Support Costs (VAMOSC) [9] can yield factors for projecting:

a. Direct Costs -

(1) Aircraft Operation (OMN)

(2) Aircraft Rework (OMN)

(3) Replenishment Spares (/PN)

(4) Personnel (MPN)

b. Indirect Costs -

(1) Indirect: OMN

(2) Indirect: MPN

Factors obtained from NARM and VAMOSC should be interpreted with considerable caution as advised in the source data itself. Best source of resource factors is NATRACOM where the factors are supported by empirical evidence but some resource requirements must be set forth at a level above the NATRACOM because of shared facilities, cognizance of costs or some cause with effects not visible to CNATRA.

CNET Instruction 7310.2A describes the reporting requirements for CNATRA on cost to train matters [10].

3.2.16 NASC DSFM Subsystem. This subsystem has the same components as the UPT DSFM Subsystem, i.e., network, algorithm and computer program; however, the sequencing of setting up the descriptive inputs is in contrast to the UPT. For NASC, the student sources and availabilities must be determined before the network can be sketched in any detail. It is the Navy's sources of student inputs that usually introduce the variability in the network configuration.

Consider Figure 3.21 which contains a trial list of Student Naval Aviator (SNA) accessions for FY82 to become graduate pilots during or about FY83. Here the AOCs have been tentatively set at 975 -- often this number is left open because it is usually the variable in determining the total inputs in one year to make the PTRs for the following year. There are no AVROC accessions this year because of a change in their NASC training pattern which will put them through the Aviation Officer Candidate School (AOCS) instead of the Aviation Pre-Flight Indoctrination (APFI). There will be AVROC accessions in subsequent years. The Limited Duty Officer (LDO) program is an innovative move to produce PROP instructor pilots using the fleet squadrons as the source. These students obtain their commission upon the successful completion of the UPT program. They will enter AOCS as one full class. The Enlisted Commissioning Program (ECP) is also a fleet source but these SNA accessions are commissioned upon completion of AOCS. This completes the FY SNA inputs to the AOCS classes during FY82. After

PILOT ACCESSIONS FOR FY 82

STUDENT SOURCE	NUMBER AVAILABLE	NASC ATTRITION	NUMBER ENTERING PRIMARY	FLIGHT ATTRITION	UPT GRADS	WEEKS AT NASC*	TIME SPAN AVAILABLE	FY 83 PTRs
AOC	975	15	829	23	638	13	Anytime but summer preferred.	
AVROC	0#	15	0	23	0	13	1 JUL to 31 DEC	
LDO	35	15	30	19	24	13	Anytime but summer preferred.	
ECP	10	15	9	23	7	13	Anytime.	
SUB-TOTAL	1020		868		669			
ROLLOVERS	300	2	294	23	226	5	1 OCT to 31 MAY	
USNA	70	2	69	18	57	5	1 JUL to 1 OCT	
NROTC(S)	65	2	64	23	49	5	1 JUN to 1 OCT	
NROTC(C)	10	2	10	32	7	5	1 JUN to 1 OCT	
FLEET	50	2	49	20	39	5	Anytime.	
NFO->SNA	30	0	30	15	26	0	Anytime.	
USN-TOTAL	1545		1384		1073			1070
USMC	705	2	691	20	553	5	Anytime but uniform input preferred.	550
USCG	57	2	56	20	45	5	Schedule fixed by USCG.	50
FOREIGN	83	2	81	20	65	5	Anytime - very uncertain	81
TOTAL	2390		2212		1736			1751

*From convening date.

#125 entering during last half of CY82 to be counted as FY83 accessions.

Figure 3.21

the NASC Subsystem has been executed on these data, this trial list will undergo some minor adjustments that will become visible in Section 3.3 when the outputs are discussed.

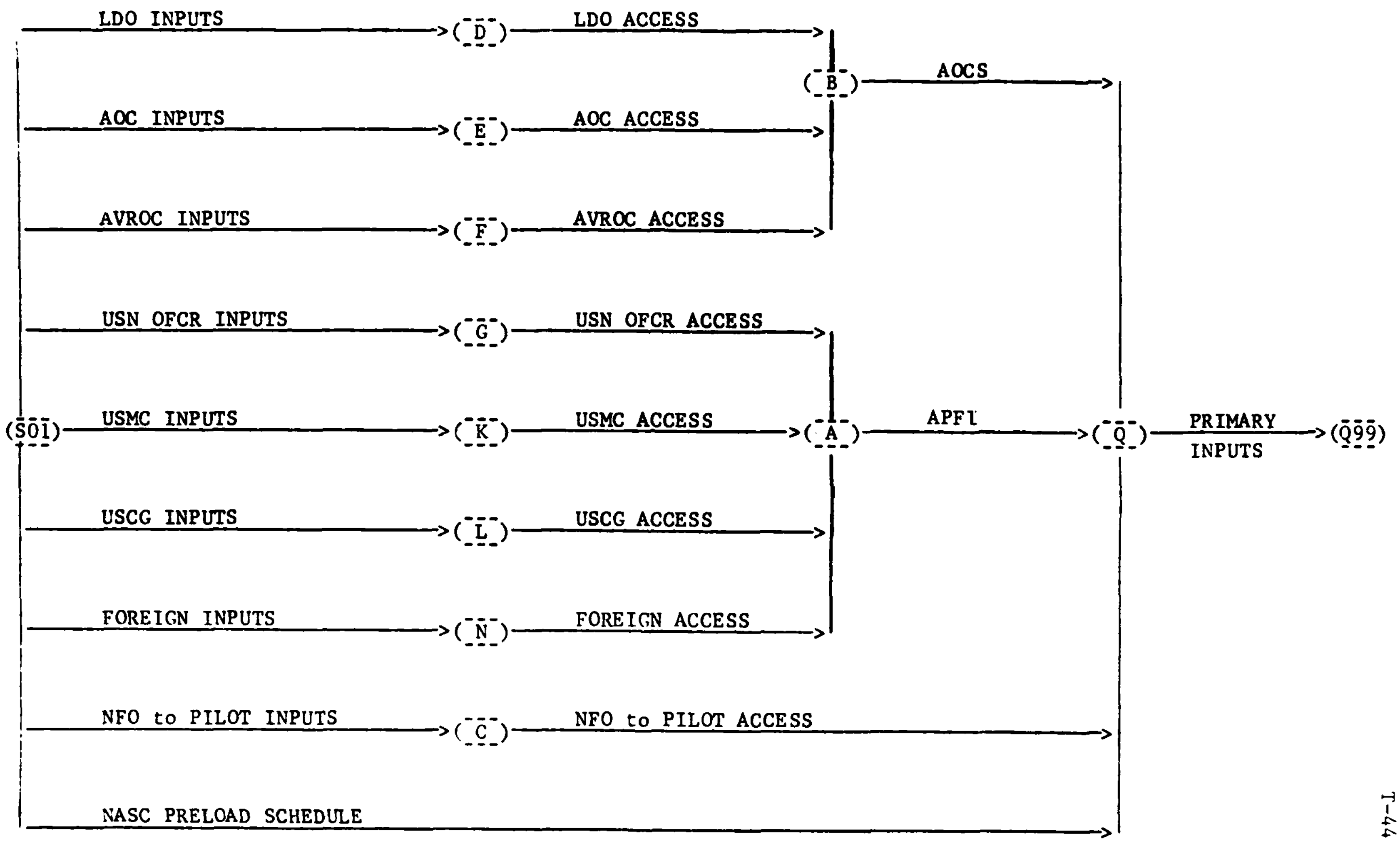
The Navy inputs to the APFI class are composed of Rollovers (previous year USNA grads), current year USNA grads, NROTC (scholarship and collegiate) and fleet applicants. The total number of these inputs by type is usually set administratively. The USMC inputs are estimated as 705 in this example but may be increased or decreased as needed to make PTR. The USCG has a fixed number of inputs and a weekly input schedule from year to year. Foreign inputs are 'estimated' at 83 but this number is very fuzzy. These combined sources comprise the APFI classes of FY82.

The NFO-to-Pilot program provides the opportunity for the NFO to switch over to pilot in the same type of operational aircraft in which he has gained fleet experience. Since they have already been through an NASC class to become an NFO, they bypass that and enter at the Primary (PR) flight level as shown in Figure 3.22. This figure also shows the entry paths of the other sources.

The NASC Preload Schedule contains all the actual or scheduled inputs into NASC prior to FY82 that would enter PR during FY82. All capacity values have been reduced for NASC attrition to show the expected number to enter PR.

The main function of the 'INPUT' arcs in Figure 3.22 is to contain the total number of students from this particular source that is available during any particular year. The main function of the 'ACCESS' arcs is to describe the time period when students from a particular source are available to enter NASC and at what maximum and minimum rates per week. Figure 3.23 is an input schedule which reflects the accession schedule in Figure 3.21 as it is interpreted in terms of the arc parameters for the network in Figure 3.22.

The weekly AOCS and APFI classes have a maximum capacity -- currently rated at 45 for each class. These classes must accommodate the NFO, AI and AMDO communities as well as the SNAs; therefore the maximum percentage of SNAs is currently estimated to be 60% in AOCS and 85% in APFI. This yields an SNA capacity of 27 and 38, respectively, and 23 and 37 when reduced for NASC attrition.



Note: This figure is identical to Figure 3.7. It is repeated here for the convenience of the reader.

NASC NETWORK

Figure 3.22

NASC INPUT SCHEDULE

ARC	FROM NODE YZZ	TO NODE YZZ	MAXIMUM CAPACITY "C"	MINIMUM CAPACITY "M"	TIME "L"	ATTRI-TION % "A"
			INPUT ARCS			
S01-G	101	152	9999	0	0	0
USN OFCR	201	201	350	350	0	0
INPUTS	202	234	0	0	0	0
	235	235	75	75	0	0
	236	239	0	0	0	0
	240	240	70	70	0	0
	241	252	0	0	0	0
	301	301	350	350	0	0
	302	334	0	0	0	0
	335	335	75	75	0	0
	336	339	0	0	0	0
	340	340	70	70	0	0
	341	352	0	0	0	0
	401	401	350	350	0	0
	402	434	0	0	0	0
	435	435	75	75	0	0
	436	439	0	0	0	0
	440	440	70	70	0	0
	441	452	0	0	0	0
	501	501	350	0	0	0
	502	552	0	0	0	0
			75			
S01-K	101	152	9999	0	0	0
USMC	201	201	710	710	0	0
INPUTS	202	252	0	0	0	0
	301	301	710	710	0	0
	302	352	0	0	0	0
	401	401	710	710	0	0
	402	452	0	0	0	0
	501	501	710	0	0	0
	502	552	0	0	0	0
S01-L	101	552	9999	0	0	0
USCG						
INPUTS						
S01-N	101	152	9999	0	0	0
FOREIGN	201	201	83	83	0	0
INPUTS	202	252	0	0	0	0
	301	301	83	83	0	0
	302	352	0	0	0	0
	401	401	83	83	0	0
	402	452	0	0	0	0
	501	501	83	0	0	0
	502	552	0	0	0	0

Figure 3.23a

NASC INPUT SCHEDULE

ARC	FROM NODE YZZ	TO NODE YZZ	MAXIMUM CAPACITY "C"	MINIMUM CAPACITY "M"	TIME "L"	ATTRI-TION % "A"
			INPUT ARCS			
S01-D	010	152	9999	0	0	0
LDO&ECP	201	201	45	45	0	0
INPUTS	202	252	0	0	0	0
	301	301	45	45	0	0
	302	352	0	0	0	0
	401	401	45	45	0	0
	402	452	0	0	0	0
	501	501	45	0	0	0
	502	552	0	0	0	0
S01-E AOC INPUTS	101	552	9999	0	0	0
S01-F	101	152	9999	0	0	0
AVROC	201	239	0	0	0	0
INPUTS	240	240	75	75	0	0
	241	252	0	0	0	0
	301	301	50	50	0	0
	302	339	0	0	0	0
	340	340	75	75	0	0
	341	352	0	0	0	0
	401	401	50	50	0	0
	402	439	0	0	0	0
	440	440	75	75	0	0
	441	452	0	0	0	0
	501	501	125	0	0	0
	502	552	0	0	0	0
S01-C	101	152	0	0	0	0
NFO-->SNA	201	201	30	30	0	0
INPUTS	202	252	0	0	0	0
	301	301	30	30	0	0
	302	352	0	0	0	0
	401	401	30	30	0	0
	402	452	0	0	0	0
	501	501	30	0	0	0
	502	552	0	0	0	0

Figure 3.23b

NASC INPUT SCHEDULE

ARC	FROM NODE YZZ	TO NODE YZZ	MAXIMUM CAPACITY "C"	MINIMUM CAPACITY "M"	TIME "L"	ATTRITION % "A"
			ACCESS ARCS			
D-B	101	152	*	*	0	0
LDO&ECP	201	227	2	0	0	0
ACCESS	228	228	35	35	0	0
	229	327	2	0	0	0
	328	328	35	35	0	0
	329	427	2	0	0	0
	428	428	35	35	0	0
	429	452	2	0	0	0
	528	528	35	0	0	0
	529	552	0	0	0	0
E-B	101	152	*	*	0	0
AOC	201	227	25	0	0	0
ACCESS	228	238	15	0	0	0
	239	327	25	0	0	0
	328	338	15	0	0	0
	339	427	25	0	0	0
	428	438	15	0	0	0
	439	527	25	0	0	0
	528	538	15	0	0	0
	539	552	25	0	0	0
				0		
F-B	101	239	0	0	0	0
AVROC	240	310	10	2	0	0
ACCESS	311	339	0	0	0	0
	340	410	10	2	0	0
	411	439	0	0	0	0
	440	510	10	2	0	0
	511	539	0	0	0	0
	540	552	10	0	0	0
F-A	101	152	*	*	0	0
AVROC	201	552	0	0	0	0
ACCESS						
G-A	101	152	*	*	0	0
USN OFCR	201	221	15	4	0	0
ACCESS	222	233	7	4	0	0
	234	321	15	4	0	0
	322	333	7	4	0	0
	334	421	15	4	0	0
	422	433	7	4	0	0
	434	521	15	0	0	0
	522	552	7	0	0	0

Figure 3.23c

NASC INPUT SCHEDULE

ARC	FROM NODE YZZ	TO NODE YZZ	MAXIMUM CAPACITY "C"	MINIMUM CAPACITY "M"	TIME "L"	ATTRI-TION % "A"
ACCESS ARCS						
K-A	101	152	*	*	0	0
USMC	201	452	20	10	0	0
ACCESS	501	552	20	0	0	0
L-A	101	452	*	*	0	0
USCG	501	552	5	0	0	0
ACCESS						
N-A	101	152	*	*	0	0
FOREIGN	201	552	5	0	0	0
C-Q						
NFO-->SNA	101	152	*	*	0	0
ACCESS	201	552	1	0	0	0
CLASS ARCS						
B-Q	101	152	*	*	13	15
AOCS	201	227	27	15	13	15
	228	228	35	35	13	15
	229	327	27	15	13	15
	328	328	35	35	13	15
	329	427	27	15	13	15
	428	428	35	35	13	15
	429	552	27	0	13	15
A-Q	101	152	*	*	5	2
	201	552	40	15	5	2
PRIMARY ENTRY ARCS						
Q-Q99	101	552	*	*	0	0

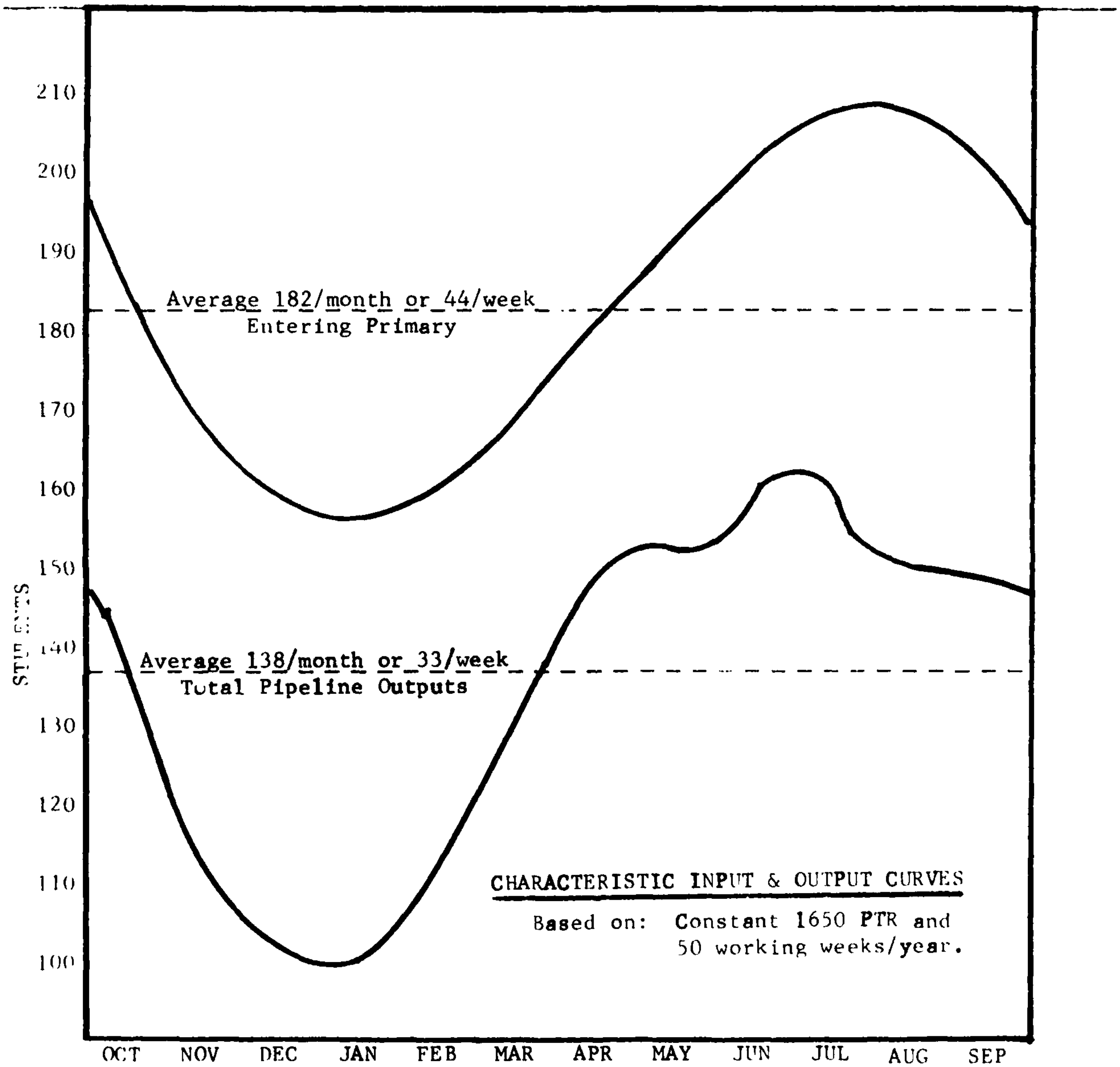
Figure 3. 23d

The 'PRIMARY INPUTS' (Q to Q99) are the weekly inputs previously determined by the execution of the UPT DSFM Subsystem.* These weekly inputs have cyclical ups and downs due to the influence of seasonal variations alone. Figure 3.24 is a graphic illustration of this cyclical movement with a hypothetical constant 1650 PTR. Other factors may further perturbate the dynamic input requirements. This is one of the entirely new dimensions offered by the DSFM. Heretofore, it has not been feasible to project the future inputs into PR which would maximize the total throughput as well as minimize student pooling. A manual procedure is simply not practical. The NASC DSFM Subsystem will function without a UPT DSFM solution. The Q to Q99 PRIMARY INPUTS may be described in any arbitrary manner and for many exercises this may produce some interesting results. If there are minor changes to the inputs for a recent DSFM solution, then an extrapolation based on the existing flow solution may suffice for an immediate need. A device for doing this is shown in Figure 3.25 which is readily constructed from the flow solution in the following way. For each pipeline find the shortest chain flow from the first week in each FY quarter and connect a line from the beginning of that first week to the appropriate week when students may graduate as shown in the figure. The number of students entering PR and the number of students graduating are taken directly from the quarterly Staff Summary in the DSFM printed solution. Figure 3.26 is similar with the quarterly outputs for each pipeline being uniform rather than the pipeline inputs. This technique for extrapolating from a known solution may serve many purposes but for the officially promulgated NASC input schedules, a recent updated UPT DSFM solution is highly recommended.

Following the exercise of the NASC DSFM Subsystem to obtain an SNA input schedule into NASC there will normally be some residual class capacity in the AOCS and APFI classes. This plus the 40% and 15% capacities, respectively, held in reserve can now be used to obtain an input schedule for NFOs, AIs and AMDOs. Figure 3.27 contains the tentative accessions for these students which pairs with the SNAs in Figure 3.21. The results are combined with the SNA inputs for the inspection and acquiescence of all activities involved. This combination is best done manually although the DSFM could be used for this purpose. There may be one or more iterations before a smooth input schedule can be agreed upon. What we have is a starting point which is in cadence with the dynamic production

---

* If the UPT Subsystem produces results containing shortfalls in the PTR, then student inputs are augmented to make up for the shortfalls since the official student input schedules are geared to the PTR and not to the projected training capacity. Moreover, if shortfalls are projected, certain management actions can be taken which will prevent the shortfalls from taking place.



STUDENTS
210
200
190
180
170
160
150
140
130
120
110
100
Average 182/month or 44/week
Entering Primary
Average 138/month or 33/week
Total Pipeline Outputs
CHARACTERISTIC INPUT & OUTPUT CURVES
Based on: Constant 1650 PTR and
50 working weeks/year.
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP

Figure 3.24

QUARTERLY PIPELINE ENTRIES INTO PRIMARY

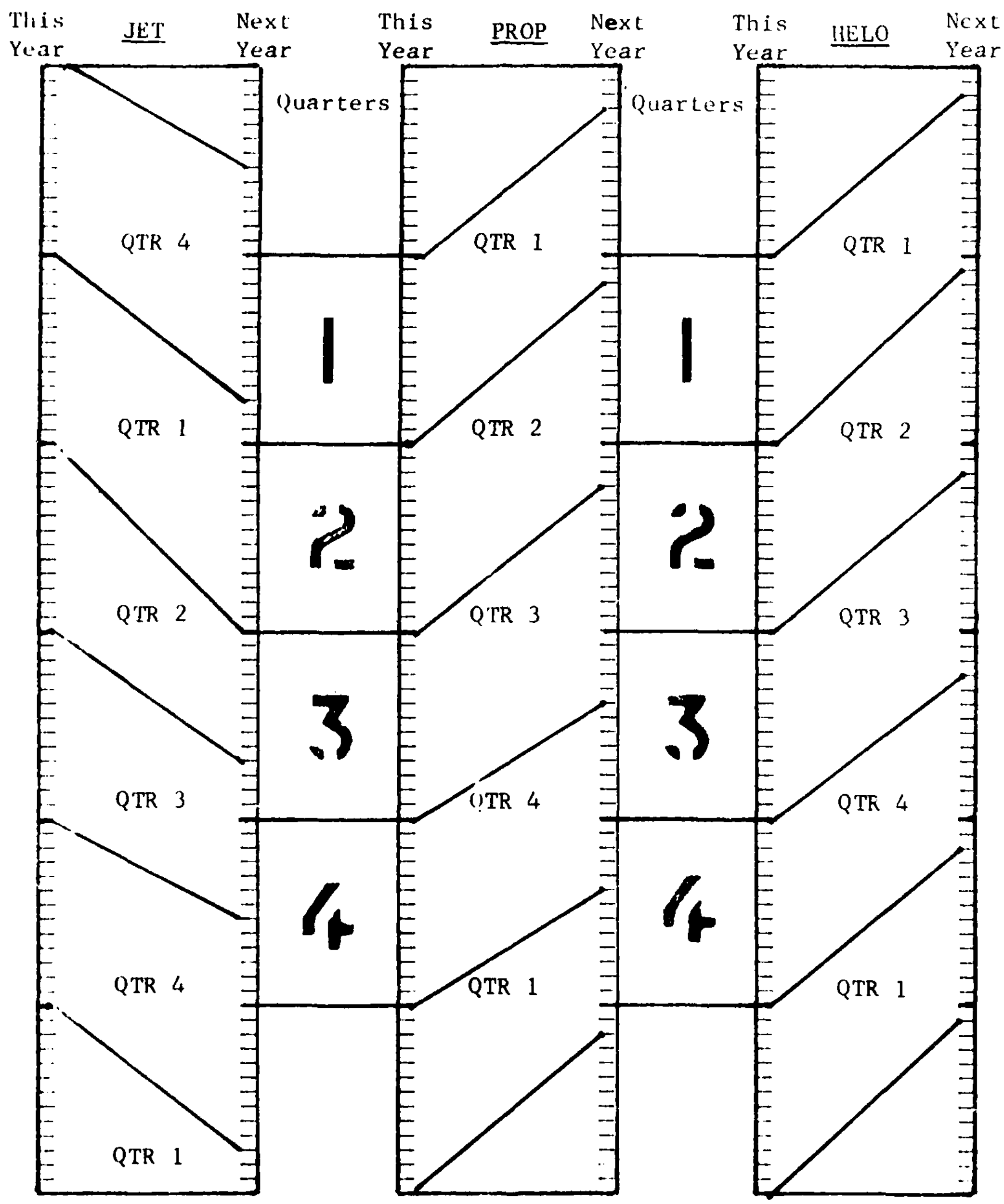


Figure 3.25

QUARTERLY PIPELINE COMPLETIONS FROM PRIMARY

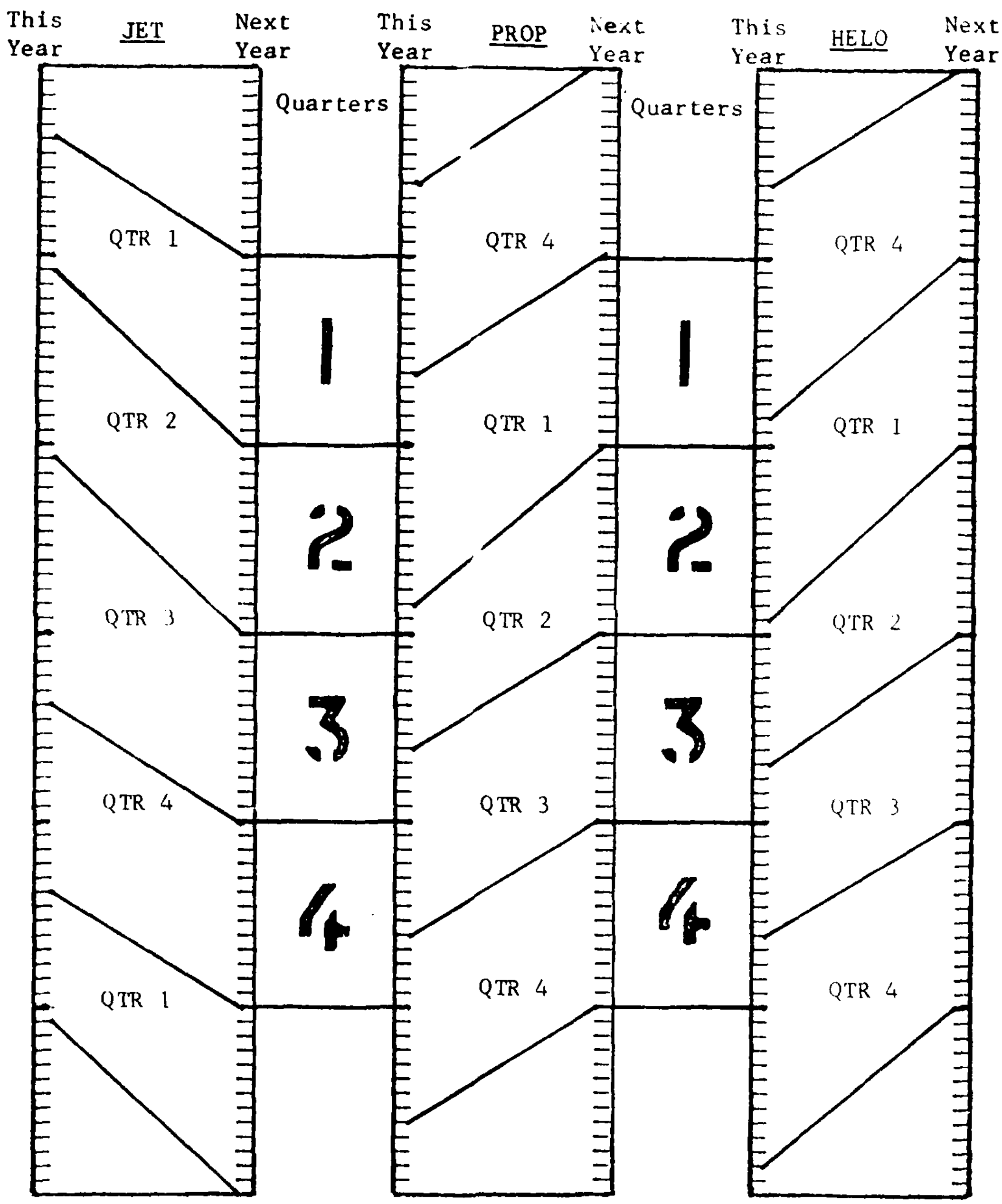


Figure 3.26

NFO ACCESSIONS FOR FY 82

STUDENT SOURCE	NUMBER AVAILABLE	NASC ATTRITION	NUMBER ENTERING PRIMARY	FLIGHT ATTRITION %	NFO GRADS	WEEKS AT NASC*	TIME SPAN AVAILABLE	FY 83 PTRs
AOC	523	15	445	27	325	13	Anytime but summer preferred.	
AVROC							1 JUL to 31 DEC	
LDO							Anytime but summer preferred.	
ECP	5	15	4	27	3	13	Anytime.	
SUB-TOTAL								
ROLLOVERS	141	2	138	8	127	5	1 OCT to 31 MAY	
USNA	57	2	56	8	52	5	1 JUL to 1 OCT	
NROTC(S)	45	2	44	12	39	5	1 JUN to 1 OCT	
NROTC(C)	6	2	6	32	4	5	1 JUN to 1 OCT	
FLEET	20	2	20	20	16	5	Anytime.	
NFO->SNA							Anytime.	
USN-TOTAL					566			566
USMC	58						Anytime but uniform input preferred.	
USCG							Schedule fixed by USCG.	
FOREIGN							Anytime - very uncertain	
TOTAL								

*From convening date.
Note: There are 75 A. and [illegible] AMDC to enter AOCS during the year.

Figure [illegible]

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capacity of the UPT SNA program. This provides a firm basis for compromise on the ancillary schedules.

We have addressed only one year's input to NASC. Normally, the 'PRIMARY INPUTS' in Figure 3.22 produced by a UPT DSFM run will contain three years of weekly input requirements. Best estimates of the categories of entrants into NASC should be used for the available inputs to construct input schedules for the out-years. In practice, the ability to plan to a three year horizon rather than one year ahead has been popular with the various agents charged with providing student entrants; even though the schedules for years two and three may prove to be 'straw men', they provide a common reference point for all concerned.

Student pool arcs are allowed at all nodes in the NASC Network in Figure 3.22 except S01 and Q99. For all pool arcs except Q to Q, the chronological string of pool arcs is broken for the week separating fiscal years so that students intended as entrants for one year cannot be helo over for the next year when a new input schedule takes over.

3.2.17 FRS.

a. Graduates of UPT receive SERE training enroute to their assigned FRS. There is an East Coast location near Brunswick, ME and a West Coast location near San Diego, CA. The West Coast convenes on the average about three classes a month and the East Coast about two classes a month. Since students graduate from UPT every week (except Christmas and New Year), there can be many occasions where no SERE class is available when the trainee arrives unless there is close coordination among the PCS order-writing authorities, the East and West SERE schedules of convening dates and the projected output of the UPT program. Similarly, there are times when graduates from SERE cannot be accommodated by the various FRS convening dates without a delay of some weeks.

b. There are at least 28 FRSs. Each of them is unique in some way from the others, perhaps by mission, syllabus, student body, environment, available facilities or operating circumstances. There are some fairly common characteristics, however, that contrast with the UPT program.

(1) Student Body. Starting dates for classes are a month or more apart while UPT has 50 classes a year. Class sizes are usually smaller than the classes entering Primary flight in UPT, although more categories of students are trained in an FRS. The categories are the following ones.

CAT I - Full syllabus - normally first tour pilots - occasionally experienced - first tour in type - all UPT grads are CAT I.

CAT II - Approximately 70-80% of syllabus - normally not current - second tour in type.

CAT III - Approximately 40-50% of syllabus - current in model.

CAT IV - Varies from 10% for tactical to 65% for helo - this is the miscellaneous category.

CAT V - Foreign and special student syllabus.

The FRS DSFM subsystem will be concerned only with the CAT I students that are fresh UPT grads. The NFO community also has members in the training classes of many of the FRSs, which involves shared syllabi and coordinated scheduling.

(2) The FRS filght training is not usually the dominant activity at the air facility at which it is located. In the UPT program, just the opposite is true.

(3) Weather and daylight hours are significant factors in the training rate in UPT, but these factors have much less influence on the more advanced FRS training.

(4) UPT has a dedicated aircraft carrier, the LEXINGTON, for carrier qualification flights. The LEXINGTON gets some use by the FRS community, but most squadrons require the larger fleet carrier. The availability of fleet carrier deck time is, to some extent, a variable. This is, perhaps, the biggest single constraint on the training rate of the tactical FRSs.

c. Convening dates for SERE classes are published annually by the Fleet Aviation Specialized Operational Training Group (FASOTRAGRU) for the Pacific and Atlantic Fleets, respectively.

d. Convening dates for the FRSs are published annually by OpNav letter originated by the Aviation Training and Manpower Division (Op59). Separate letters for the Pacific and Atlantic Fleets are distributed with a breakdown by squadron, convening date, estimated completion date, and number of pilots/NFOs in each category.

e. It is anticipated that planning factors will have more direct application in the FRS DSFM subsystem than in the UPT DSFM subsystem. FRS planning factors are routinely updated annually in accordance with OPNAV INSTRUCTION 3760.13 [11]. The range of planning factors include for each squadron and aircraft model:

(1) Operating Factors

Scheduled days

Weather factor

Flyable days

(2) Students

Attrition

Weeks to complete

Hours to complete

(3) Aircraft

Availability factor

Average sortie length

Turnaround time

Hours per student

Utilization per flyable day

(4) Instructor

Availability factor

Contact time per student

Utilization per student

Flight hours per student

Planning factors are classified by student categories where this is relevant, but, as mentioned before, we are interested only in CAT I students.

f. Training progress is reported by the FRSs in accordance with OPNAV INSTRUCTION 3500.31D [12]. Much useful DSFM information is contained in these reports such as the experienced weeks to train, the actual onboard load of students by category, etc.

3.3 Output Requirements.

3.3.1 Basic UPT DSFM Subsystem Outputs.

a. The following types of information are routinely available from this subsystem of the DSFM. The information may be displayed by weekly, quarterly or annual increments.

(1) Students entering a phase of training.

(2) Phase training capacity for entrants.

(3) Students graduating a phase of training.

(4) Phase training capacity for graduates.

(5) Students attriting from a phase of training.

(6) Students on board in a phase of training.

(7) Phase onboard capacity.

(8) Unused phase training capacity for entrants.

(9) Unused phase training capacity for graduates.

(10) Students in pool status at entry to a phase of training.

(11) Students in transit to next phase of training.

(12) Resource utilization by phase of training.

(13) Resource planned by phase of training.

b. Types 12 and 13 above allow phase graduates (Type 12) and phase capacity (Type 13) to be converted through planning factor information to list resource requirements, both utilized and planned, respectively. Examples of the resources that can be displayed are:

(1) Aircraft flight hours.

(2) Instructor flight hours.

(3) Aircraft inventory.

(4) Instructors.

(5) Maintenance personnel.

(6) Direct costs -

Aircraft Operation (OMN)

POL

O&I-level maintenance

Aircraft Rework (OMN)

Engine overhaul

Component rework

SDLM

Replenishment Spares (APN)

Personnel (MPN)

Indirect costs -

Indirect (OMN)

Indirect (MPN)

As a practical matter, Types 12 and 13 data will be aggregated at the quarterly and annual levels only, since weekly increments would appear to have little worth.

c. The standard formats for information Types 1 through 11 have been geared for the executive, staff and analyst levels.

(1) Executive Summary: This is a one page report giving yearly values only. Figure 3.28 is a typical example listing the data elements normally displayed.

(2) Staff Summary: This is a quarterly report displaying one of the data types 1 through 11 by phase, then another by phase and so forth. Figure 3.29 is an example of a partial listing for Phase Graduates (Type 3) by quarter for three years. A complete set of Staff Summary outputs is contained in Appendix C.

(3) Analyst Report: This report displays the weekly values for any data element by phase for Types 1 through 11. In the example, Figure 3.30, there is a listing of the number of student-weeks in pools awaiting entry (Type 10) into the Primary phase. For FY81, there were scheduled inputs into NASC. For FY82 and FY83, the UPT DSFM subsystem decided what the optimum input schedule into Primary would be. Initially in FY81 there was no pool for there was a mild shortage of students coming in. Pools start to build during Week 7 and peak out at Week 28, receding to zero on the first week of FY82. This is due to too many being scheduled in during FY81. (Actually, the pools never got that big because there were some shortages in fulfilling the input schedule and a marked increase in attrition in the AOCS.) During FY82 and FY83, a buffer or insurance pool of 74 was specified and as soon as the DSFM took control (Week 6 into Primary), that pool was formed and held.

When the training system is being pushed to capacity, it can be noted from the Analyst Report that some pooling is necessary to obtain the maximum throughput, notably into the longer phases, Intermediate and Advanced Strike. This is due to seasonal variations in the environmental conditions. Sometimes it can be aggravated by a less than optimal student input schedule into Primary and some may be due to an imbalance in the total system. One would have to look at the total analyst listings to get a grasp of the cause for this effect. The point here is that the weekly breakdown of student flow activity would give the trained analyst a probe into student flows not heretofore possible. Annual totals may be sufficient to sound the alarm at the executive and senior staff

05/14/81 PATHFINDER - DYNAMIC STUDENT FLOW MODEL 075151
BASIC UPT - FY81 WK1 - SOLUTION 8A.26

EXECUTIVE SUMMARY

	FY81	FY82	FY83
GRADUATES			
JET	562	545	567
MARITIME	396	422	437
HELO	579	640	668
PTR			
JET	576	634	646
MARITIME	396	422	437
HELO	579	640	668
TOTAL	1551	1696	1751
SHORTFALLS			
JET	14	89	79
MARITIME	0	0	0
HELO	0	0	0
STUDENTS FROM SCHOOLS COMMAND	2092	2294	2244
STUDENT-WEEKS IN POOLS	3901	5283	7290
CNATRA AOB	1667	1778	1882
IN PHASE	1547	1627	1691
IN TRANSIT	41	44	45
IN POOL	78	105	145

Figure 3.28

05/14/81 PATHFINDER - DYNAMIC STUDENT FLOW MODEL
BASIC UPT - FY81 WK1 - SOLUTION 8A.26 075151

FULL STAFF SUMMARY

GRADUATES		FY81	FY82	FY83
STUDENTS FROM SCHOOLS COMMAND		2092	2294	2244
	FQ1	470	537	479
	FQ2	490	446	455
	FQ3	545	638	638
	FQ4	587	673	672
PRIMARY		1681	1805	1867
	FQ1	333	366	400
	FQ2	331	366	372
	FQ3	540	573	594
	FQ4	477	500	501
INTERMEDIATE STRIKE		577	595	628
	FQ1	137	113	114
	FQ2	127	123	123
	FQ3	143	174	206
	FQ4	170	185	185
ADVANCED STRIKE		562	545	567
	FQ1	121	116	118
	FQ2	118	110	129
	FQ3	186	156	157
	FQ4	137	163	163
PHASED MARITIME		396	422	437
	FQ1	77	88	88
	FQ2	81	88	88
	FQ3	122	136	151
	FQ4	116	110	110

Figure 3.29

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ANALYST REPORT

AVERAGE STUDENT WEEKS IN POOLS

	FY81	FY82	FY83		FY81	FY82	FY83
INTO PRIMARY					58	67	74
FQ1	19	46	74	FQ3	87	74	74
FW01	0	0	74	FW27	99	74	74
FW02	0	3	74	FW28	118	74	74
FW03	0	6	74	FW29	112	74	75
FW04	0	14	74	FW30	96	74	74
FW05	0	17	74	FW31	91	74	74
FW06	0	74	74	FW32	86	74	74
FW07	8	74	74	FW33	79	74	74
FW08	23	74	74	FW34	83	74	74
FW09	59	76	74	FW35	81	74	74
FW10	61	74	74	FW36	74	74	74
FW11	63	74	74	FW37	74	74	74
FW12	21	74	74	FW38	74	74	74
				FW39	75	74	74
FQ2	90	74	74	FQ4	35	74	74
				FW40	71	75	74
FW15	51	83	74	FW41	75	74	74
FW16	52	74	74	FW42	70	74	74
FW17	72	74	74	FW43	62	74	74
FW18	72	74	74	FW44	55	74	74
FW19	75	74	74	FW45	46	74	74
FW20	109	74	74	FW46	29	74	74
FW21	105	74	74	FW47	18	74	74
FW22	112	74	74	FW48	4	74	74
FW23	116	74	74	FW49	12	74	74
FW24	111	74	74	FW50	14	74	74
FW25	108	74	74	FW51	8	74	74
FW26	101	74	74	FW52	1	74	74

Figure 3.30

levels but the detailed analyst listing provides the necessary tools for an intrinsic comprehension of what is being projected and the making of explicit recommendations for action to avoid the unwanted events.

(4) Resource Utilization/Availability Report: This is an optional report displaying the Type 12 and Type 13 information by the year and quarter for each phase. Figure 3.31 is an example for Intermediate and Advanced Strike. Contractor maintenance is used for some of the aircraft types so the data elements are not uniform for every phase.

3.3.2 NASC DSFM Output.

a. The NASC network is normally run following a UPT network run. The student pilot flow requirements are then set to match the input requirements into the Primary flight training phase for as many years as the UPT DSFM was run. This is normally set at three years. The specific output of the NASC DSFM is a student input schedule for SNAs by source, i.e., AOC, USMC, USCG, etc. These schedules are produced typically for three years hence. Figure 3.32 is an example of a one-year schedule. This can be compared to the OpNav example in Figure 3.16 for format similarity.

b. Following the production of the SNA input schedules, the NFO/AI/AMDO schedule is developed in much the same way except that the inputs are matched to NASC output requirements that were established outside the UPT DSFM. The NASC classes start each week, excepting the Christmas holidays, and they have a fixed maximum size. A minimum number of student seats are reserved during the SNA calculations for the NFO/AI/AMDO communities. The final schedule, as composed by the DSFM Analyst, is constrained by the residual classroom capacities remaining from the SNA schedule. Figure 3.33 is a one-year example which matches with the SNA schedule in Figure 3.32.

c. Figure 3.34, composed by the DSFM Analyst, is a working schedule of all NASC students showing that the maximum class size has not been violated. This schedule may be used for making trade-offs between student types. Figure 3.34 is a combination of Figures 3.32 and 3.33.

d. Figure 3.35 is a sample of the NASC DSFM subsystem output listing the weekly NASC graduates that would be entering Primary flight training.

3.3.3 FRS DSFM Outputs. The output of the UPT DSFM subsystem provides the inputs to the FRS DSFM subsystem. This is suboptimization in the strict

PATHFINDER – DYNAMIC STUDENT FLOW MODEL

03/25/81 BASIC UPT – FY81 WK1 – SOLUTION 8A.26 111519

RESOURCE UTILIZATION/AVAILABILITY REPORT

—INTERMEDIATE STRIKE—		FY81	FY82	FY83
TOTAL FLIGHT HOURS (100S) UTILIZED		821	888	934
	FQ1	181	191	197
	FQ2	169	197	223
	FQ3	232	255	270
	FQ4	238	243	243
TOTAL FLIGHT HOURS (100S) PLANNED		965	967	967
	FQ1	217	214	214
	FQ2	230	235	235
	FQ3	270	270	270
	FQ4	247	247	247
INSTRUCTOR FLIGHT HOURS (100S) UTILIZED		727	786	827
	FQ1	160	169	174
	FQ2	149	175	198
	FQ3	206	226	239
	FQ4	211	215	215
INSTRUCTOR FLIGHT HOURS (100S) PLANNED		855	857	857
	FQ1	192	190	190
	FQ2	203	208	208
	FQ3	239	239	39
	FQ4	219	219	219
AIRCRAFT INVENTORY UTILIZED		137	149	156
AIRCRAFT INVENTORY PLANNED		161	162	162
INSTRUCTORS UTILIZED		151	163	171
INSTRUCTORS PLANNED		177	177	177
MAINTENANCE PERSONNEL UTILIZED		988	1068	1124
MAINTENANCE PERSONNEL PLANNED		1161	1164	1164

Figure 3. 1a

03/25/81 PATHFINDER - DYNAMIC STUDENT FLOW MODEL
BASIC UPT - FY81 WK1 - SOLUTION 8A.26 111519

RESOURCE UTILIZATION/AVAILABILITY REPORT

--ADVANCED STRIKE--		FY81	FY82	FY83
TOTAL FLIGHT HOURS (100S) UTILIZED		874	865	895
	FQ1	197	181	201
	FQ2	213	188	198
	FQ3	230	247	248
	FQ4	233	247	247
TOTAL FLIGHT HOURS (100S) PLANNED		940	940	941
	FQ1	209	207	207
	FQ2	222	225	225
	FQ3	261	261	261
	FQ4	247	247	247
INSTRUCTOR FLIGHT HOURS (100S) UTILIZED		697	690	714
	FQ1	157	145	160
	FQ2	169	150	158
	FQ3	183	197	198
	FQ4	186	197	197
INSTRUCTOR FLIGHT HOURS (100S) PLANNED		750	750	750
	FQ1	167	165	165
	FQ2	177	179	179
	FQ3	208	208	208
	FQ4	197	197	197
AIRCRAFT INVENTORY UTILIZED		143	142	147
AIRCRAFT INVENTORY PLANNED		154	154	154
INSTRUCTORS UTILIZED		160	158	164
INSTRUCTORS PLANNED		172	172	172
MAINTENANCE PERSONNEL UTILIZED		1132	1120	1159
MAINTENANCE PERSONNEL PLANNED		1218	1218	1218

Figure 3.31b

03/25/81 PATHFINDER - DYNAMIC STUDENT FLOW MODEL 111519
BASIC UPT - FY81 WK1 - SOLUTION 8A.26

RESOURCE DEMONSTRATION REPORT

	FY81	FY82	FY83
--INTERMEDIATE STRIKE--			
DIRECT COSTS (O&MN) (K$)			
FLIGHT OPNS - POL & MAINT	22161	23961	25213
AIRFRAME REWORK	6477	7003	7369
ENGINE OVERHAUL	5760	6228	6554
MISC SUPPORT	12558	13578	14287
DIRECT COSTS (PAMN) (K$)			
SPARE PARTS	6350	6866	7225
INDIRECT COSTS (O&MN) (K$)			
LOGISTICS SUPPLY SUPPORT	722	780	821
LOGISTICS OTHER	6031	6520	6861
--ADVANCED STRIKE--			
DIRECT COSTS (O&MN) (K$)			
FLIGHT OPNS - POL & MAINT	27908	27608	28561
AIRFRAME REWORK	5537	5477	5666
ENGINE OVERHAUL UTILIZED	1915	1895	1960
ENGINE OVERHAUL PLANNED	2060	2060	2061
DIRECT COSTS (PAMN) (K$)			
SPARE PARTS	1672	1654	1711
INDIRECT COSTS (O&MN) (K$)			
LOGISTICS SUPPLY SUPPORT	553	547	566
LOGISTICS OTHER	3189	3155	3264

Figure 3.31c

USFN 10.10/8.2G

PROPOSED AVIATION (PILOT) INPUT LOADING PLAN - FY82 THROUGH FY84

2/17/81

FY 82		AOC				AVROC				OFFICLR				USNC				USCG				FOREIGN			
		P		A		P		A		P		A		P		A		P		A		P		A	
CL CVN	CL NO	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM
			312																						
10/05/81	1*	15	327			2	2			15	15			13	13			0	0			5	5		
10/12/81	2	15	342			2	4			12	27			10	23			2	2			0	5		
10/19/81	3	15	357			2	6			14	41			11	34			2	4			0	5		
10/26/81	4	15	372			2	8			5	46			10	44			0	4			0	5		
11/02/81	5	15	387			2	10			4	50			10	54			1	5			0	5		
11/09/81	6	15	402			0	10			5	55			10	64			0	5			0	5		
11/16/81	7	15	417			0	10			14	69			10	74			0	5			0	5		
11/23/81	8	15	432			0	10			5	74			11	85			0	5			0	5		
11/30/81	9	16	448			0	10			[illegible]	[illegible]			10	95			2	7			0	5		
12/07/81	10	20	468			0	10			4	82			10	105			2	9			0	5		
12/14/81	11	24	492			0	10			16	98			15	120			0	9			5	10		
1/11/82	12	24	516			0	10			14	112			10	130			2	11			0	10		
1/18/82	13	24	540			0	10			12	124			11	141			2	13			0	10		
1/25/82	14	24	564			0	10			15	139			10	151			2	15			0	10		
2/01/82	15	24	588			0	10			11	150			10	161			2	17			0	10		
2/08/82	16	24	612			0	10			9	159			11	172			2	19			2	12		
2/15/82	17	24	636			0	10			4	163			11	183			2	21			5	17		
2/22/82	18	24	660			0	10			14	177			13	196			2	23			0	17		
3/01/82	19	24	684			0	10			7	184			20	216			2	25			5	22		
3/08/82	20	24	708			0	10			8	192			18	234			2	27			0	22		
3/15/82	21	24	732			0	10			6	198			10	244			2	29			4	26		
3/22/82	22	25	757			0	10			6	204			13	257			0	29			5	31		
3/29/82	23	25	782			[illegible]	10			7	211			18	275			0	29			0	31		
[illegible]	24	24	806			[illegible]	[illegible]			7	218			19	294			1	30			0	31		
[illegible]	25*	35	841			[illegible]	10			7	225			19	313			1	31			2	33		

[illegible] ... AVROC ... for FY82 but 125 will enter AOCS ... [illegible] ... class 25 is composed of [illegible] prospective flying [illegible].

Figure 2.3[illegible]

FY 82		AOC				AVROC				OFFICER				USMC				USCG				FOREIGN			
		P		A		P		A		P		A		P		A		P		A		P		A	
CL CVN	CL NO	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM
			841				10				225				313				31				33		
4/19/82	26	14	855			0	10			7	232			14	327			2	33			3	36		
4/26/82	27	14	869			0	10			7	239			17	344			2	35			5	41		
5/03/82	28	15	884			0	10			7	246			16	360			1	36			4	45		
5/10/82	29	15	899			0	10			7	253			20	380			1	37			6	51		
5/17/82	30	14	913			0	10			7	260			21	401			1	38			5	56		
5/24/82	31	15	928			0	10			15	275			15	416			0	38			1	57		
5/31/82	32	14	942			0	10			15	290			20	436			0	38			0	57		
6/07/82	33	15	957			0	10			15	305			20	456			0	38			5	62		
6/14/82	34	14	971			0	10			15	320			20	476			0	38			1	63		
6/21/82	35	15	986			0	10			15	335			20	496			0	38			4	67		
6/28/82	36	24	010			0	10			15	350			20	516			0	38			5	72		
7/05/82	37	25	25			9	9			15	365			20	536			2	40			2	74		
7/12/82	38	24	49			9	18			15	380			20	556			2	42			3	77		
7/19/82	39	24	73			10	28			15	395			20	576			2	44			2	79		
7/26/82	40	24	97			10	38			15	410			21	597			2	46			2	81		
8/02/82	41	25	122			10	48			15	425			10	607			1	47			0	81		
8/09/82	42	20	142			3	51			15	440			20	627			1	48			1	82		
8/16/82	43	20	162			3	54			15	455			20	647			1	49			1	83		
8/23/82	44	20	182			4	58			15	470			12	659			2	51			0	83		
8/30/82	45	20	202			3	61			6	476			10	669			2	53			0	83		
9/06/82	46	20	222			4	65			4	480			10	679			1	54			0	83		
9/13/82	47	20	242			3	68			4	484			11	690			1	55			0	83		
9/20/82	48	20	262			3	71			7	491			10	700			1	56			0	83		
9/27/82	49	20	282			4	75			4	495			10	710			1	57			0	83		
										30	525														

[illegible] contains 30 NFO to SNA who will enter Primary Flight Training in small numbers throughout the year. They do [illegible] the regular API course.

Figure 3.32b

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USERS MANUAL FOR THE DYNAMIC STUDENT FLOW MODEL.(U)
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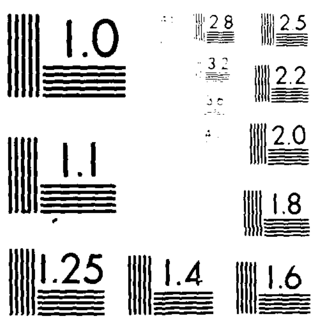

MICROCOPY RESOLUTION TEST CHART

PROPOSED AVIATION (NFO/AI/AMDO) INPUT LOADING PLAN

2/25/81

FY 82		NFOC				AVROC				OFFICER				USMC				AI				AMDOC			
		P		A		P		A		P		A		P		A		P		A		P		A	
CL CVN	CL NO	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM
			173																21				15		
10/05/81	1	10	183			0	0			5	5			2	2			2	23			1	16		
10/12/81	2	10	193			0	0			5	10			2	4			1	24			1	17		
10/19/81	3	10	203			0	0			5	15			2	6			2	26			1	18		
10/26/81	4	10	213			0	0			5	20			1	7			1	27			1	19		
11/02/81	5	10	223			0	0			5	25			1	8			2	29			1	20		
11/09/81	6	10	233			0	0			5	30			1	9			1	30			0	20		
11/16/81	7	10	243			0	0			5	35			1	10			2	32			1	21		
11/23/81	8	9	252			0	0			5	40			1	11			1	33			1	22		
11/30/81	9	9	261			0	0			5	45			1	12			2	35			1	23		
12/07/81	10	9	270			0	0			5	50			1	13			1	36			1	24		
12/14/81	11	9	279			0	0			5	55			1	14			2	38			1	25		
1/11/82	12	9	288			0	0			5	60			1	15			1	39			0	25		
1/18/82	13	9	297			0	0			5	65			1	16			2	41			1	26		
1/25/82	14	9	306			0	0			5	70			1	17			1	42			1	27		
2/01/82	15	9	315			0	0			5	75			1	18			2	44			1	28		
2/08/82	16	9	324			0	0			5	80			1	19			1	45			1	29		
2/15/82	17	9	333			0	0			5	85			1	20			2	47			1	30		
2/22/82	18	9	342			0	0			5	90			1	21			1	48			0	30		
3/01/82	19	9	351			0	0			5	95			1	22			2	50			1	31		
3/08/82	20	9	360			0	0			5	100			1	23			1	51			1	32		
3/15/82	21	9	369			0	0			5	105			1	24			2	53			1	33		
3/22/82	22	9	378			0	0			5	110			1	25			1	54			1	34		
3/29/82	23	9	387			0	0			5	115			1	26			2	56			1	35		
4/05/82	24	9	396			0	0			5	120			1	27			2	58			1	36		
4/12/82	25	9	405			0	0			5	125			1	28			1	59			0	36		

Figure 3.33a

PROPOSED AVIATION (NFO/AI/AMDO) INPUT LOADING PLAN 2/25/81

F Y 8 2		N F O C				A V R O C				O F F I C E R				U S M C				A I				A M D O C			
		P		A		P		A		P		A		P		A		P		A		P		A	
CL CVN	CL NO	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM	WK	CM
			405				0				125				26				59				36		
4/19/82	26	9	414			0	0			5	130			1	29			1	60			1	37		
4/26/82	27	9	423			0	0			5	135			1	30			2	62			1	38		
5/03/82	28	9	432			0	0			5	140			1	31			1	63			1	39		
5/10/82	29	9	441			0	0			5	145			1	32			2	65			1	40		
5/17/82	30	9	450			0	0			5	150			1	33			1	66			0	40		
5/24/82	31	9	459			0	0			5	155			1	34			2	68			1	41		
5/31/82	32	9	468			0	0			5	160			1	35			1	69			1	42		
6/07/82	33	15	483			0	0			4	164			1	36			2	71			1	43		
6/14/82	34	15	498			0	0			8	172			1	37			1	72			1	44		
6/21/82	35	15	513			0	0			5	177			1	38			2	74			1	45		
6/28/82	36	15	528			0	0			4	181			1	39			1	75			0	45		
7/05/82	37	8	8			0	0			5	186			1	40			2	2			1	1		
7/12/82	38	10	18			0	0			4	190			1	41			1	3			1	2		
7/19/82	39	8	26			0	0			5	195			1	.42			2	5			1	3		
7/26/82	40	9	35			0	0			5	200			1	43			1	6			1	4		
8/02/82	41	7	42			0	0			18	218			1	44			2	8			1	5		
8/09/82	42	18	60			2	2			7	225			1	45			1	9			1	6		
8/16/82	43	18	78			1	3			7	232			1	46			2	11			1	7		
8/23/82	44	18	96			1	4			7	239			2	48			1	12			1	8		
8/30/82	45	18	114			1	5			6	245			2	50			2	14			1	9		
9/06/82	46	18	132			1	6			6	251			2	52			1	15			1	10		
9/13/82	47	18	150			1	7			6	257			2	54			2	17			1	11		
9/20/82	48	18	168			2	9			6	263			2	56			1	18			1	12		
9/27/82	49	18	186			0	9			6	269			2	58			2	20			1	13		
/ /	50																								

Figure 3.33b

NASC FLOW CHART 2/25/81

FY 82		AOCS							APFI							
						AVROC			NAVY		USMC		USCG		FORN
CL CVN	CL NO	AOC	NFOC	A I	AMDO	SNA	NFO	TOTAL	SNA	NFO	SNA	NFO	SNA	TOTAL	SNA
10/05/81	1	17	10	2	1	0	0	30	15	5	13	2	0	35	5
10/12/81	2	17	10	1	1	0	0	29	12	5	10	2	2	31	0
10/19/81	3	17	10	2	1	0	0	30	14	5	11	2	2	34	0
10/26/81	4	17	10	1	1	0	0	29	5	5	10	1	0	21	0
11/02/81	5	17	10	2	1	0	0	30	4	5	10	1	1	21	0
11/09/81	6	15	10	1	0	0	0	26	5	5	10	1	0	21	0
11/16/81	7	15	10	2	1	0	0	28	14	5	10	1	0	30	0
11/23/81	8	15	9	1	1	0	0	26	5	5	11	1	0	22	0
11/30/81	9	16	9	2	1	0	0	28	4	5	10	1	2	22	0
12/07/81	10	20	9	1	1	0	0	31	4	5	10	1	2	22	0
12/14/81	11	24	9	2	1	0	0	36	16	5	15	1	0	37	5
1/11/82	12	24	9	1	0	0	0	34	14	5	10	1	2	32	0
1/18/82	13	24	9	2	1	0	0	36	12	5	11	1	2	31	0
1/25/82	14	24	9	1	1	0	0	35	15	5	10	1	2	33	0
2/01/82	15	24	9	2	1	0	0	36	11	5	10	1	2	29	0
2/08/82	16	24	9	1	1	0	0	35	9	5	11	1	2	28	2
2/15/82	17	24	9	2	1	0	0	36	4	5	11	1	2	23	5
2/22/82	18	24	9	1	0	0	0	34	14	5	13	1	2	35	0
3/01/82	19	24	9	2	1	0	0	36	7	5	20	1	2	35	5
3/08/82	20	24	9	1	1	0	0	35	8	5	18	1	2	34	0
3/15/82	21	24	9	2	1	0	0	36	6	5	10	1	2	24	4
3/22/82	22	25	9	1	1	0	0	36	6	5	13	1	0	25	5
3/29/82	23	25	9	2	1	0	0	37	7	5	18	1	0	31	0
4/05/82	24	24	9	2	1	0	0	36	7	5	19	1	1	33	0
4/12/82	25	35	9	1	0	0	0	45	7	5	19	1	1	33	2

Figure 3.34a

NASC FLOW CHART

2/25/81

FY 82		AOCS							APFI						
						AVROC			NAVY		USMC		USCG		FORN
CL CVN	CL NO	AOC	NFOC	A I	AMDO	SNA	NFO	TOTAL	SNA	NFO	SNA	NFO	SNA	TOTAL	SNA
4/19/82	26	14	9	1	1	0	0	25	7	5	14	1	2	29	3
4/26/82	27	14	9	2	1	0	0	26	7	5	17	1	2	32	5
5/03/82	28	15	9	1	1	0	0	26	7	5	16	1	1	30	4
5/10/82	29	15	9	2	1	0	0	27	7	5	20	1	1	34	6
5/17/82	30	14	9	1	0	0	0	24	7	5	21	1	1	35	5
5/24/82	31	15	9	2	1	0	0	27	15	5	15	1	0	36	1
5/31/82	32	14	9	1	1	0	0	25	15	5	20	1	0	41	0
6/07/82	33	15	15	2	1	0	0	33	15	4	20	1	0	40	5
6/14/82	34	14	15	1	1	0	0	31	15	8	20	1	0	44	0
6/21/82	35	15	15	2	1	0	0	33	15	5	20	1	0	41	4
6/28/82	36	24	15	1	0	0	0	40	15	4	20	1	0	40	5
7/05/82	37	25	8	2	1	9	0	45	15	5	20	1	2	43	2
7/12/82	38	24	10	1	1	9	0	45	15	4	20	1	2	42	3
7/19/82	39	24	8	2	1	10	0	45	15	5	20	1	2	43	2
7/26/82	40	24	9	1	1	10	0	45	15	5	21	1	2	44	2
8/02/82	41	25	7	2	1	10	0	45	15	18	10	1	1	45	0
8/09/82	42	20	18	1	1	3	2	45	15	7	20	1	1	44	1
8/16/82	43	20	18	2	1	3	1	45	15	7	20	1	1	44	1
8/23/82	44	20	18	1	1	4	1	45	15	7	12	2	2	38	0
8/30/82	45	20	18	2	1	3	1	45	6	6	10	2	2	26	0
9/06/82	46	20	18	1	1	4	1	45	4	6	10	2	1	23	0
9/13/82	47	20	18	2	1	3	1	45	4	6	11	2	1	24	0
9/20/82	48	20	18	1	1	3	2	45	7	6	10	2	1	26	0
9/27/82	49	20	18	2	1	4	0	45	4	6	10	2	1	23	0
	50														

Figure 3.34b

DYNAMIC STUDENT FLOW MODEL

[illegible]/31/81 **NAVY NASC - FY81 SCHEDULED - SOLUTION 10.10** 095314

ANALYST REPORT

NASC GRADUATES	FY81	FY82	FY83	FY84	FY85
NASC	2065	2264	2219	1944	348
FQ1	489	526	475	472	330
FW01	44	48	49	33	30
FW02	39	49	43	30	30
FW03	42	46	44	30	30
FW04	47	45	47	30	30
FW05	30	46	45	30	30
FW06	38	53	30	54	30
FW07	44	45	31	54	30
FW08	40	45	32	54	30
FW09	37	36	30	30	30
FW10	50	44	40	48	30
FW11	42	30	41	39	15
FW12	36	39	43	40	15
FQ2	460	448	462	428	18
FW15	39	30	30	30	18
FW16	41	31	31	33	0
FW17	40	31	34	41	0
FW18	39	50	54	40	0
FW19	15	15	15	15	0
FW20	47	41	42	31	0
FW21	41	39	40	31	0
FW22	37	41	42	38	0
FW23	42	38	39	41	0
FW24	35	39	41	42	0
FW25	37	41	41	42	0
FW26	47	52	53	44	0
FQ3	528	620	619	571	0
FW27	27	34	34	34	0
FW28	43	46	45	33	0
FW29	34	43	43	40	0
FW30	35	45	45	46	0
FW31	41	47	46	46	0
FW32	43	47	48	47	0
FW33	43	50	49	48	0
FW34	47	48	48	48	0
FW35	46	51	50	49	0
FW36	44	49	52	47	0
FW37	41	54	54	42	0
FW38	41	54	52	43	0
FW39	43	52	53	48	0
FQ4	588	670	663	473	0
FW40	48	52	52	53	0
FW41	55	54	53	51	0
FW42	42	51	51	51	0
FW43	40	53	53	48	0
FW44	42	54	53	30	0
FW45	44	54	54	30	0
FW46	42	54	52	30	0
FW47	43	53	52	30	0
FW48	44	53	53	30	0
FW49	48	40	38	30	0
FW50	47	51	51	30	0
FW51	46	51	51	30	0
FW52	47	50	50	30	0

Figure 3.35

sense of the continuous flow of students from entry into UPT until they are assigned to a fleet squadron, but there is general agreement among the principals that the critical linkages in the production chain are in the UPT program and will remain so for an indefinite time in the future. Moroever, any partitioning of the total network has a practical payoff in terms of data processing storage space and running times. The outputs from the FRS DSFM will be a selected subset of the output Types 1 through 11 listed in 3.3.1 (a) above as may be requested by the user community.

3.3.4 SNA Training Paths. The DSFM has the capability of decomposing a flow solution into separate paths tracing student entrants to pipeline graduates. Figure 3.36, Chain Flow Decomposition, is a listing of some of the paths leading to Helo Graduates. Each line lists a path giving the number of pipeline graduates (FLOW), the length in weeks of the path (TL), and the DSFM nodes defining the path. The Chain Flow Decomposition listing lists all paths by pipeline.

For most purposes, the details of a path are of little concern. The interest lies in the date of entry versus the date of graduation. Figure 3.37, Input/Output Correspondence Schedule, is an example of a more compact listing that contains three pipelines per page. At the left is the year and week of graduation. For each pipeline the listing diaplays the Input Phase, year and week of entry, the number of students, and the total number of weeks in the system (TL).

Since the UPT DSFM does not distinguish among the different student sources, e.g., Navy AOC, Navy officers, USMC, etc., this report provides a convenient device for scheduling different students by source with their different pipeline attrition rates.

3.4 Utilization of System Outputs. There should always be a currently endorsed edition of the UPT DSFM Executive and Staff Summaries available at the TRAWINGS, NASC and all relevant CNATRA staff divisions. This 'management' version should be based on the most realistic input data and should be of the level of detail shown in Figure 3.4 These results could be based on that network but if online data storage and processing time are a problem, then the network in Figure 3.5 could be used and the pipeline networks could be calculated separately using the PR outputs as the input schedule. This requires that the PR and IP phases at Whiting and Corpus are calculated first using the PR inputs determined from the Figure 3.5 run. As detail is added, the total throughput is often diminished. For instance, when the jet pipeline is treated as being conducted at one locat-

THE DYNAMIC STUDENT FLOW MODEL

10/22/81 BASIC UPT - FY81 WK27 - SOLUTION 138.1 170916

CHAIN FLOW DECOMPOSITION

FLOW	TL	HELO GRADUATES
7	65	ONBRD-R140-T140-T141-U145-U146-V151-V152-V201-V202-V203-V204-H220
6	66	ONBRD-R140-T140-T141-U145-U146-V151-V152-V201-V202-V203-V204-V205-H221
4	66	ONBRD-R141-T141-U145-U146-V151-V152-V201-V202-V203-V204-V205-H221
2	46	POOL -Q127-Q128-Q129-Q130-Q131-R146-T146-U150-U151-U152-V205-H221
12	47	POOL -Q127-Q128-Q129-Q130-Q131-R146-T146-U150-U151-U152-U201-V206-H222
2	48	INPUT-Q127-Q128-Q129-Q130-Q131-R146-T146-U150-U151-U152-V205-V206-V207-H223
9	48	INPUT-Q127-Q128-Q129-Q130-R145-T145-U149-U150-U151-U152-V205-V206-V207-H223
6	49	INPUT-Q127-Q128-Q129-Q130-R145-T145-U149-U150-U151-V204-V205-V206-V207-V208-H224
1	49	INPUT-Q127-Q128-Q129-R144-T144-T145-U149-U150-U151-V204-V205-V206-V207-V208-H224
5	49	INPUT-Q127-Q128-Q129-R144-T144-U148-U149-U150-U151-V204-V205-V206-V207-V208-H224
1	49	INPUT-Q128-Q129-R144-T144-U148-U149-U150-V203-V204-V205-V206-V207-V208-V209-H225
1	49	INPUT-Q128-Q129-R144-T144-U148-U149-V202-V203-V204-V205-V206-V207-V208-V209-H225
2	49	INPUT-Q128-Q129-R144-T144-U148-V201-V202-V203-V204-V205-V206-V207-V208-V209-H225
7	49	INPUT-Q128-Q129-R144-T144-U148-U149-U150-U151-U152-U201-U202-U203-V209-H225
9	50	INPUT-Q128-Q129-Q130-Q131-Q132-Q133-Q134-Q135-Q136-R151-T151-U204-V210-H226
3	49	INPUT-Q129-Q130-Q131-Q132-Q133-Q134-Q135-Q136-R151-T151-U204-V210-H226
5	49	INPUT-Q129-Q130-Q131-Q132-Q133-Q134-Q135-R150-T150-U203-V209-V210-V211-H226
6	49	INPUT-Q129-Q130-Q131-Q132-Q133-Q134-R149-T149-U202-V208-V209-V210-V211-H226
4	50	INPUT-Q129-Q130-Q131-Q132-Q133-Q134-R149-T149-U202-V208-V209-V210-V211-V212-H227
2	49	INPUT-Q130-Q131-Q132-Q133-Q134-R149-T149-U202-V208-V209-V210-V211-V212-H227
4	49	INPUT-Q130-Q131-Q132-Q133-Q134-Q135-Q136-R151-T151-T152-U205-V212-H227
7	49	INPUT-Q131-Q132-Q133-Q134-Q135-R150-T150-U203-U204-U205-U206-V215-H228
4	49	INPUT-Q131-Q132-Q133-R148-T148-U201-U202-U203-U204-U205-U206-V215-H228
3	50	INPUT-Q131-Q132-Q133-R148-T148-U201-U202-U203-U204-U205-U206-U207-V216-H229
5	49	INPUT-Q132-Q133-R148-T148-U201-U202-U203-U204-U205-U206-U207-V216-H229
3	49	INPUT-Q132-R147-T147-U152-U201-U202-U203-U204-U205-U206-U207-V216-H229
4	49	INPUT-Q132-R147-T147-U152-U201-U202-U203-U204-U205-U206-U207-U208-V217-H229
6	49	INPUT-Q132-R147-T147-U152-U201-U202-U203-U204-U205-V212-V215-V216-V217-H229
1	49	INPUT-Q132-Q133-Q134-Q135-Q136-Q137-Q138-Q139-R203-T203-U209-V217-H229
6	49	INPUT-Q133-Q134-Q135-Q136-Q137-Q138-Q139-Q140-R204-T204-U210-V218-H230
3	48	INPUT-Q134-Q135-Q136-Q137-Q138-Q139-Q140-R204-T204-U210-V218-H230
1	48	INPUT-Q134-Q135-Q136-Q137-Q138-Q139-R203-T203-U209-V217-V218-H230
10	48	INPUT-Q135-Q136-Q137-Q138-Q139-Q140-Q141-R205-T205-U211-V219-H231
1	48	INPUT-Q135-Q136-Q137-Q138-Q139-R203-T203-U209-V217-V218-V219-H231
3	48	INPUT-Q135-Q136-Q137-Q138-Q139-Q140-Q141-Q142-R206-T206-U212-V220-H231
6	47	INPUT-Q136-Q137-Q138-Q139-Q140-Q141-Q142-R206-T206-U212-V220-H231
2	47	INPUT-Q136-Q137-Q138-Q139-R203-T203-U209-V217-V218-V219-V220-H231
4	48	INPUT-Q136-Q137-Q138-Q139-R203-T203-U209-V217-V218-V219-V220-V221-H232
6	48	INPUT-Q136-Q137-Q138-R202-T202-U207-U208-V217-V218-V219-V220-V221-H232
12	48	INPUT-Q137-R201-T201-U206-U207-U208-U209-U210-U211-U212-U215-V222-H233

Figure 3.36

10/22/81

THE DYNAMIC STUDENT FLOW MODEL
BASIC UPT - FY81 WK27 - SOLUTION 138.1

170916

INPUT/OUTPUT CORRESPONDENCE SCHEDULE

ALL VALUES IN TERM OF PIPELINE GRADUATES

GRADUATE		HELO GRADUATES					JET GRADUATES					PROP GRADUATES				
YR	WK	INPUT PHASE	YR	WK	STUDS	TL	INPUT PHASE	YR	WK	STUDS	TL	INPUT PHASE	YR	WK	STUDS	TL
		Q NORMAL INPUT	01	46	2	44	PRIMARY PRELOAD	ONBRD		6	63					
		Q NORMAL INPUT	01	46	2	44	PRIMARY PRELOAD	ONBRD		1	63					
							Q NORMAL INPUT	01	29	9	61					
02	39	Q NORMAL INPUT	01	47	2	44	Q NORMAL INPUT	01	29	5	62					
		Q NORMAL INPUT	01	48	10	43	Q NORMAL INPUT	01	31	3	60					
							Q NORMAL INPUT	01	31	1	60					
							Q NORMAL INPUT	01	32	2	59					
02	40	Q NORMAL INPUT	01	49	12	43	Q NORMAL INPUT	01	32	3	60	Q NORMAL INPUT	01	49	8	43
							Q NORMAL INPUT	01	32	2	60					
							Q NORMAL INPUT	01	33	6	59					
02	41	Q NORMAL INPUT	01	49	5	44	Q NORMAL INPUT	01	33	4	60	Q NORMAL INPUT	01	50	8	43
		Q NORMAL INPUT	01	50	7	43	Q NORMAL INPUT	01	33	4	60					
		Q NORMAL INPUT	01	50	1	43	Q NORMAL INPUT	01	34	3	59					
		Q NORMAL INPUT	01	51	2	42	Q NORMAL INPUT	01	34	9	59					
							Q NORMAL INPUT	01	35	1	58					
02	42	Q NORMAL INPUT	01	51	1	43	Q NORMAL INPUT	01	35	8	59	Q NORMAL INPUT	01	51	8	43
		Q NORMAL INPUT	01	52	3	42	Q NORMAL INPUT	01	35	3	59					
		Q NORMAL INPUT	01	52	3	42										
		Q NORMAL INPUT	01	52	2	42										
		Q NORMAL INPUT	02	01	5	41										
02	43	Q NORMAL INPUT	02	01	13	42	Q NORMAL INPUT	01	35	5	60	Q NORMAL INPUT	01	52	8	43
		Q NORMAL INPUT	02	01	1	42	Q NORMAL INPUT	01	36	6	59					
		Q NORMAL INPUT	02	01	1	42										
02	44	Q NORMAL INPUT	02	01	1	43	Q NORMAL INPUT	01	36	3	60	Q NORMAL INPUT	01	52	4	44
		Q NORMAL INPUT	02	01	1	43	Q NORMAL INPUT	01	37	9	59	Q NORMAL INPUT	02	01	5	43
		Q NORMAL INPUT	02	01	1	43						Q NORMAL INPUT	02	01	8	43
		Q NORMAL INPUT	02	02	12	42										
02	45	Q NORMAL INPUT	02	02	5	43	Q NORMAL INPUT	01	37	9	60	Q NORMAL INPUT	02	02	8	43
		Q NORMAL INPUT	02	02	1	43	Q NORMAL INPUT	01	38	3	59					
		Q NORMAL INPUT	02	03	9	42										
02	46	Q NORMAL INPUT	02	03	6	43	Q NORMAL INPUT	01	38	12	60	Q NORMAL INPUT	02	03	9	43
		Q NORMAL INPUT	02	03	1	43	Q NORMAL INPUT	01	38	5	60					
		Q NORMAL INPUT	02	04	8	42	Q NORMAL INPUT	01	39	6	59					
02	47	Q NORMAL INPUT	02	04	3	43	Q NORMAL INPUT	01	39	12	60	Q NORMAL INPUT	02	04	8	43
		Q NORMAL INPUT	02	04	3	43										
		Q NORMAL INPUT	02	04	1	43										
		Q NORMAL INPUT	02	05	8	42										

Figure 3.37

tion, this is tantamount to saying that the resource allocations are perfectly balanced among the TRAWINGS. When the four jet bases are treated separately, this assumption may breakdown.

External distribution of the DSFM outputs is an executive decision beyond the pale of this Users Manual.

The distribution of the Analyst Report should be restricted to the CNATRA DSFM Analyst except for some selected portions of it. The week-by-week projections of, say, phase graduates is not a good management tool but it is a good tool for the DSFM Analyst. On the other hand, the weekly trend in pooling can be a good alerting device for management that is not otherwise visible in the Staff Summary which displays quarterly data. The DSFM does not produce outputs in monthly increments because months do not equate to a fixed number of weeks; however, a fair approximation of monthly data can be derived from the quarterly in the Staff Summary in the following manner. Let us say that the number of graduates for a particular phase and location is equal to Q and the ratio of the number of scheduled days in the first month to the total number of scheduled days in the quarter is R_1. Then the monthly number of graduates for the first month is:

$$Q_1 = R_1Q .$$

For example, the third quarter of FY81 has 64 scheduled days with 22 in APR, 20 in MAY and 22 in JUN. Therefore, $Q_1 = .34Q$; $Q_2 = .32Q$; and $Q_3 = .34Q$.

If the inputs to the DSFM are reasonable and the TRAWING commanders agree that they can support the projections on production, then the expectations may, to a certain extent, become self-fulfilling predictions because all segments of the UPT system will know what is expected from all other segments. There would be a common frame of reference for discourse among all echelons of command. Timely management action can be taken. Of course, if there is a substantive change to the DSFM inputs or if the projections are considerably off the mark of what is actually occurring, then the model should be updated and restarted.

The variety of ad hoc scenarios that can be represented by the DSFM is so broad that the scope and level of detail to be contained in a particular network cannot be defined in advance. Generally speaking, the guidance for these considerations will be evident in the senario itself. The amenability of the model in projection of the effects from hypothetical situations involving policy changes, inovative management actions or precipitous changes in the available

training resources should lead to its frequent use in evaluating WHIF circumstances. Impact statements using the quantitative results from a DSFM run would be supportable in great detail. The key individual in the exercising of the model is the staff DSFM Analyst.

SECTION 4. ADVANCED TECHNIQUES

This section contains descriptive information on the application of some features built into the DSFM program that, at most, have only been alluded to in earlier sections. A discussion of these advanced techniques has been deliberately deferred to this final section because a working comprehension of these capabilities depends on a clear understanding of the fundamentals of the DSFM.

4.1 Alternate Capacity Computation. As explained in Section 3.2.14, a basic input to the UPT DSFM is the average number of phase graduates per week, C , for every phase in the system. The method of determining the value of C is independent of the operation of the DSFM. It can be arbitrarily assigned or calculated on the basis of some rationale. This average is based on the average maximum production rate to be expected over an entire year for a given set of operating circumstances. The number, C , need not be used in the DSFM over an entire year but the weekly production rate must be averaged over a year as though it would be. When this number has been appropriately reduced to pipeline graduates by the postphase attrition, A^+ , it is called C^+ . Then, given this input parameter, the weekly variation in the capacity to train for a particular phase may be automatically computed by the following relationship:

$$C_i^+ = C^+L/L_i \quad ,$$

where C_i^+ is defined as the maximum class size of pipeline graduates to enter at the beginning of the ith week and L_i is the expected weeks to train for that class.

The above computation results in the product of each arc's capacity to train and time to train remaining relatively constant. Use of this relationship results in a more even on board student population than does a fixed capacity scheme. However, it still exhibits a more pronounced seasonal variation than is desired. This seasonal variation in students onboard can be further reduced by taking into account all classes on board at a point in time when determining the capacity of any one class. First, note that all the classes on board for a given week must share the training resources available. Also, that a class of

L_i weeks must, on the average, receive $1/L_i$ of its training each week. Recall that L, the annual average time to train in the phase, is independent of the training year by definition. Next we calculate the sum of the times to train for all classes on board at one time for each week in a year, independent of the particular training year, to be:

$$T_i \Big|_{i=1}^{52} = \sum_{k=1}^{52} (W_i \in A_k)(t_k) \quad .$$

Where $(W_i \in A_k) = 1$ if arc k spans week i and zero otherwise. The t_k is the time to train for arc k. In this case only 50 arcs represent a training phase, one for each week beginning weeks 1 thru 12 and 15 thru 52. Only the week number is of interest, i.e., the training year is of no concern.

The capacity for each of the n arcs representing a training phase, including the designation by year, is then calculated as:

$$C_k \Big|_{k=1}^{n} = \sum_{j=1}^{5} \sum_{i=1}^{52} [(W_{ji} \in A_k)(L)(C_{@ji})]/T_i \quad .$$

Where $(W_{ji} \in A_k) = 1$ if arc k spans year j week i and zero otherwise. The $C_{@ji}$ is used to indicate the annual average class capacity which is applicable for year j and week i.

4.2 Biasing a Solution. There have been several references in the preceding text about the biasing or weighting of student flow solutions. We will take up the subject at this point. In Section 3.2 we described the basic structure of a DSFM network. In particular the node names were defined as XYZ where:

X is an alpha character identifying that class of nodes;

Y is the sequence number of the fiscal year, 1 through 5; and

Z is a number indicating the week, 1 through 52, in the fiscal year.

These names, for every node in a DSFM network, are unique in every instance. The algorithm cannot deal with ambiguity of any kind. These node names not only provide the uniqueness that is essential but also 'lock in' the chronology of each event while the student flow solution, as determined by the algorithm, describes the magnitude of that event.

Recall also that there are three parameters placed on each arc:

L: time duration in weeks,

C: maximum capacity, and

M: minimum capacity in the number of students per week.

The optimizing algorithm deals with all three of these arc parameters. It looks at the node names only as the FROM and TO nodes of a particular arc. The time duration, L , of the arc is equal to the year and week (the YZ) of the terminal node (TO) minus the year and week of the initial node (FROM). Zero time durations are admissible. However, since the algorithm ignores the temporal information contained in the node names and only looks at the arc parameter which represents the time duration, we are free to assign any value to this parameter, say B (to distinguish it from L), that suits our purpose. The real time chronology is locked in to the node IDs and when the output reports are generated, they recover this information so that the solution data is properly synchronized. When we substitute B for L , we call this biasing* the solution. This technique has powerful leverage and should always be used with extreme caution.

In the construction of any DSFM network there are many arcs that do not represent phase training as explained in Section 3.2 and delineated in Figure 3.3. There is often a preference in where you would like a certain kind of event to occur when there are alternatives that are equally likely when using the time duration, L , as the arc parameter. Since the algorithm seeks to minimize the total student time in the system, the algorithm would not care which alternative it chose. If, however, we introduce B in lieu of L and make one B greater that the other, then the algorithm will strive to select the path with the smaller B . This preference could reflect experience, policy or some other operational consideration. It is a technique which provides more guidance to the DSFM with no loss in the detail of the output information.

Influencing the location of student pools is one of the most common applications of this technique. An example may serve to bring the application into clearer focus. Take the NASC network in Figure 3.22. Let the class of nodes separating the class of INPUT arcs and ACCESS arcs be called a-nodes; the nodes between ACCESS arcs and the AOCs & APFI arcs as b-nodes; and the nodes providing the PRIMARY INPUTs (Q to Q99) as q-nodes. The L for the student pool arcs for the a, b and q-nodes is equal to one week everywhere. But the purpose of exercising the DSFM on the NASC network is to determine what the SNA input schedule should be to meet the Primary flight training entry requirements, so any holding of students in the (a to a)-arcs is essentially free because

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*The arc parameter B is often referred to as a 'cost' in the literature on network flow theory. Since 'cost' in the context of our problem is usually associated with dollar costs we have avoided that term in this discussion. You may, however, encounter the term 'cost' elsewhere in the DSFM documentation but it will mean the same as the B (for bias) used herein.

there is considerable latitude in the scheduling of inputs into the NASC system. To a lessor degree, there is some freedom in adjusting the student availability gates in the ACCESS arcs so that the (b to b)-arcs may have some pools that could be avoided by some ACCESS changes. Student pooling in the (b to b)-arcs are much more likely to be 'required' than in the (a to a)-arcs. Student pooling in the (q to q)-arcs is most likely to be a result of NASC classroom capacity constraints in meeting the PRIMARY INPUT requirements (Q to Q99) which were determined by a previous run on the UPT DSFM subsystem. These pools may not be avoidable. Accordingly, we set B equal to:

Zero on the (a to a)-arcs,
One on the (b to b)-arcs, and
Two on the (q to q)-arcs.

This reflects our preference on holding students entering the ACCESS arcs whenever possible and then at entering NASC whenever possible before any holding at entry into Primary flight training.

Of course, if no pooling is to be permitted, then the affected arcs may be deleted or, alternatively, the capacity set to zero. One instance of this is where there is to be no carryovers between fiscal years at the a-nodes. The pool arcs, (a to a), separating the fiscal years are then deleted. If pooling or carryovers are to be allowed, but only as a last resort to achieve a little more throughput, then B can be set at a very high value say 100. This will, however, increase the computation time for a flow solution.

Caution is the key word in selecting the values for B . The effect on student flows may be different than expected. The proper and conservative way is to have a flow solution using the values for L . Then create a new solution with the trial values for B being the only change. The effect of the biasing then has a benchmark.

4.3 Lower Capacity Bound Considerations. The Out-of-Kilter (OOK) algorithm by D. R. Fulkerson provides a powerful method for solving min cost/max flow problems in network models. Among the prominent features of the method are the following two that relate directly to the DSFM application.

a. Lower bounds as well as capacities are assumed for each arc flow. These lower bounds may be assigned any non-negative value not greater than the assigned capacity. The lower bound is dealt with directly by the algorithm. This feature provides the basis for the discussion in this section.

b. The method can be initiated with any circulation flow, feasible or not. For example, in actual applications, one is often interested in seeing what changes will occur in an optimal solution when some of the given data are altered. This method is tailored for such an examination, since the old solution can be used to start the new problem, thereby greatly decreasing computation time. This capability will be explored in detail in the next section on sequential solutions.

The OOK first appeared in the literature in 1961. A complete technical description of the OOK method is contained in Appendix A of reference [6] .

There are other algorithms which solve for the min cost/max flow in a network but under more restrictive conditions than the OOK. The properties of the OOK referred to above provide a compelling opportunity to predict, investigate, and control student flows in the context of the flight training program. Consider a 'supply and demand' network where the supply is represented by the student input schedule into the intial indoctrination ground school (NASC) plus the students already on board. The demand side is represented by the Pilot Training Requirements (PTR) by time periods. The intermediate network is composed of the various phases of the flight training process in as much detail as desired. To each arc in the full network there are assigned three parameters: a time duration, which is the cost coefficient of the OOK; and an upper and lower bound on student flows in the arc. The upper bound is permissive and the lower is required for a feasible solution, i.e., for a flow to be feasible, it must have a value that is on or between these bounds. An arc having a feasible flow is <u>in kilter</u> otherwise the arc is <u>out of kilter</u>.

The algorithm examines each arc no more than once, thereby guaranteeing termination since all networks have a finite number of arcs. This examination determines if the arc is 'in kiler' or 'out of kilter'. If in kilter, the arc is marked and the algorithm proceeds to the next arc. If 'out of kilter' the algorithm trys to find a circulatory flow by a set of unambiguous rules which will get the arc 'in kilter'. In so doing, it never changes an 'in kilter' arc to an 'out of kilter' arc. If it is unable to achieve such a flow, the algorithm would normally terminate with a statement that the problem is infeasible. For purposes of the DSFM, however, the program for the algorithm has been modified to proceed to the next arc in an attempt to get as many arcs 'in kilter' as possible. From an operational perspective, one is interested to learn 'how

much' is the system 'out of kilter' if, indeed, it is at all. The flow in an 'out of kilter' arc is never changed in the interests of getting another 'out of kilter' arc 'in kilter'. If the flow in the arc could have been increased, it would have been in the first attempt to get it into kilter. To take flow out of the arc would make it 'more out of kilter' than before and the rules prohibit this. The end result of processing an infeasible situation is to illuminate those arcs that are the problem but it does not indicate the least number of arcs that have to be 'out of kilter'.

The point of all this discussion is to illustrate how the algorithm works with respect to the lower bound on arc flows. The non-zero lower bound is a powerful tool in the interpretation of a wide variety of scenarios but its use must be tempered with the knowledge that these bounds constitute additional constraints on the flow problem and may make a feasible set of circumstances infeasible when the lower bound assignments are made without some serious consideration. Remember that all DSFM networks have a feasible solution when the lower bounds are zero.

In the next section, the second feature, (b) above, will be discussed in the context of the DSFM. Within the envelope of optimality, techniques have been developed for doing many useful things that are not within the direct comprehension of the optimizing algorithm.

4.4 Sequential Solutions. Sections 4.2 and 4.3 discussed parametric methods by which the user may influence which paths the OOK algorithm selects in generating a flow solution. Biasing may be termed the 'softer' method of flow control as the maximum network throughput is unaffected. Establishing lower bounds on flow, on the other hand, is a stronger method of flow control in that their use may actually decrease maximum network throughput.*

In this section the concept of sequential solutions is introduced as a technique of flow control to create solutions exhibiting desirable characteristics within a set of required characteristics. In order to discuss sequential solutions we must first discuss two important points regarding the OOK algorithm.

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* For completeness, we note here that there exists a third parametric method of flow control, i.e., that of setting the capacity values. This is the strongest method of flow control in that it sets the maximum network throughput which can be achieved when all arcs are considered to have zero lower bounds.

First: The OOK algorithm, when moving flow from arc to arc in order to increase the current network flow towards the maximum network flow, will not move flow out of an arc when doing so would leave a flow value below its lower bound's value.

Second: The OOK algorithm operates on flow circulations and maintains flow conservation at <u>all</u> nodes including the source and sink. That is, all paths located for flow augmentation terminate at their origin, which may be any node in the network. To operate in this manner the OOK algorithm requires a network having one more arc than other network algorithms. This arc is termed a 'return' arc and connects the sink to the source. It is strictly a control arc for the OOK algorithm and has no interpretation in the problem being solved. It is, however, important to note that the return arc will have a flow value equal to the total flow in a network solution.

The technique of sequential solutions may take one of two general forms, i. e., the successive alterations of flow solutions or the successive removal of flow capacity.

<u>Successive Alterations of a Flow Solution.</u> This technique begins with the generation of a flow solution with network parameters that represent the required conditions. These parameters are then altered to a) retain any required characteristics in the original solution, and b) force the flow solution to represent additional desired characteristics. A solution is then generated which will retain all required characteristics and, if possible, include the desired characteristics.

<u>Successive Removal of Flow Capacity.</u> This technique begins with the generation of a flow solution with network parameters that represent a portion of the required network throughput. The network capacity is then reduced by the flow values of this solution and the network parameters are adjusted to represent additional network throughput. A solution is then generated which will represent this additional throughput subject to the original throughput as represented by the first solution.

Three examples will be used to describe the details of sequential solutions. These are:

a) establishing a pre-primary pool,

b) pushing shortfalls towards the out-years, and

c) generating solutions by branch of service.

The first two examples utilize successive alterations of a flow solution and the third example utilizes successive removal of flow capacity.

4.4.1 Establishing a Pre-primary Pool. Lower bounds may, in general, be used to represent both required conditions, e.g. students onboard at the beginning of the time period of interest, and desired conditions, e.g., the maintenance of a minimum pre-primary pool. In the former use, students onboard must be included in the flow solution regardless of cost or throughput considerations. However, in the latter case, the pre-primary pool is to be maintained only to the extent that throughput is not compromised. This may be accomplished by a two-step process as follows:

> Construct a network containing lower bounds only where required and obtain a 'base' flow solution. This base solution exhibits the maximum flow that can be achieved under the required conditions. Now, 'lock' this base flow in the network by setting the lower bound on the return arc at or above its flow value. The base flow is now considered 'locked in' for any solution that is generated with this base solution as its starting point because the OOK algorithm will not reduce the flow in any arc below its lower bound.
>
> Next, enter lower bounds representing the desired pre-primary pool and obtain a second solution beginning with the base solution generated above. This second solution will contain the desired pre-primary pool only to the extent that it does not adversely affect pilot production during the time period of interest.

4.4.2 Pushing Shortfalls Towards the Out Years. The technique of sequential solutions may be extended to three, four, or more solutions. As an example, consider the case when the best solution contains some shortfalls in required pilot production and it is desired to determine whether or not these short falls may be deferred to later years giving management more options in planning for their elimination. The process is as follows.

> Beginning with the base solution referred to above, set the lower bound values for the first year's PTR arcs to their respective

capacities and obtain a solution based upon the base solution having minimum shortfalls in year one.

Next, set the lower bounds for the second year's PTR arcs to their respective capacities and obtain a solution based upon the first year's solution having minimum shortfalls in year two subject to minimum shortfalls in year one.

Repeat the above process for later years as desired.

If the user is producing the final solution, i.e., the one that is to generate the published input schedule requirements, the last year's minimum shortfall solution may be followed by one that adds the desired pre-primary pool. This solution would establish an input schedule meeting the desired pre-primary pool subject to the fewest shortfalls in the early years and any initial conditions imposed in the base solution.

4.4.3 Generating Solutions by Branch of Service. The prime application of successive solutions using removal of network flow capacity is the generation of flow solutions by branch of service. This is generally not of concern until a base solution having all of the desired flow characteristics has been generated for the total flow without regard to branch of service. At this point individual training phase requirements are well understood and student input/output schedules becomes of interest. This process may proceed as follows:

First, the user selects the order, by branch of service, in which the successive solutions will be made. For example, assume the order selected was Navy, Marine, Coast Guard, and Foreign.

The network parameters are then adjusted to reflect the input/output requirements for Navy and the total training capacity as determined in the base solution. Additionally, solution smoothing may be imposed by setting training lower bounds to reflect the minimum desired Navy training rate. A solution is then generated for Navy throughput.

Following this Navy solution, all training capacities are reduced by Navy flow. The network parameters are then adjusted to reflect the input/output requirements for the Marines. Additionally, solution smoothing may be imposed by setting training lower bounds to reflect the minimum desired Marine training rate. A solution is then generated for Marine throughput.

This process is repeated for the remaining branches of service.

Successive solutions formed in this manner may have an aggregate network flow less than that of the base solution. The extent to which there is a decrease in overall flow is determined by the level of saturation existing in the training phases for the base solution. Further, if there is any decrease in flow, it will result in shortfalls for the branches of service treated last in the sequence of runs. For this reason, it may be desirable to make several Branch of Service run sequences to better understand the effect of sequential solutions.

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APPENDIX A

TERMS OF REFERENCE

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APPENDIX A

Aircraft Availability. This is the observed operational availability of assigned A-1/A-4 status aircraft and does not, therefore, include "pool" status aircraft. This indicates what percent of the total assigned fleet of training aircraft are capable of performing specific scheduled mission and, if scheduled, do not fail to meet the scheduled launches for any reason other than lack of students, instructors, or flyable weather. That is, the aircraft is not in check, is not DOWN and does not go DOWN at the time of intended use or abort a mission due to a maintenance or material situation. This availability is an "operational availability" as opposed to the 24-hour 3M or readiness availability. This, then, reflects the in-commission, operationally available aircraft for the assigned specific mission. The operational availability should be observed and recorded at frequent representative intervals during the scheduled day and then averaged over a statistically meaningful span of time.

Aircraft Hours per Student. The determined average total aircraft hours required to complete the specified category of student including all prorated extra-time and ancillary hours.

Aircraft M. O. - Maintenance and Operating Factor. The current approved M O. for the type/model aircraft as taken from the current OPNAVINST 05311 series.

Aircraft Turn-Around-Time (TAT). This is the average observed time to recycle incommission aircraft. This factor plays a most important role in the utilization capability level. This factor should be observed, reviewed and updated frequently. Both empirical data and judgment must be used to consider this factor.

TAT applies to scheduled or "challenged" aircraft. It is composed of three major internal elements:

TM - Maintenance Time,
TS - Schedule Delay Time, and
TT - Turn-up and Taxi Time.

TAT commences on shutdown at chocks after return from a flight. The aircraft then may require taking care of minor squawks, routine turnaround inspections, refueling, and loading of ordnance/gun cameras or rockets. All of this goes to make up the first element, TM. At this time, the aircraft is "green flagged" and considered READY by the maintenance line crew.

Next assuming that there is not a queuing or "man when ready" policy, there will be a nominal schedule delay time, TS. This time covers the period from UP aircraft time to the pilot's acceptance of the aircraft for flight when he signs the Yellow Sheet. TS should be the normal average schedule delay period, i.e., if the aircraft is not scheduled within a reasonable period, then the elapsed time is not a normal schedule delay time. Also, in determining TAT for an aircraft, it should not be "married" to a particular pilot. Generally speaking, an aircraft can turn around faster than an instructor pilot who must, after returning from a routine training mission, fill out the Yellow Sheet, debrief his student, fill out the student jacket info, check schedule board, perhaps a head run, etc., then pick up his next student and brief him. Then the pilot picks up the Yellow Sheet and preflights the aircraft. All of this takes longer than when different pilots are scheduled for succeeding flights in the same aircraft.

TT starts when the pilots accepts the aircraft for flight. This element absorbs the delay time for turn-up, taxiing, waiting for clearance and taking position for take-off on the duty runway. TT ends at the time of takeoff.

TAT should be frequently observed on good, bad, light load and heavy load days. It should be analyzed and averaged over statistically large enough samples to be meaningful and supportable.

Aircraft Utilization - Annual Fleet. This is the total planned annual fleet utilization task, i.e., fleet utilization per flyable day times the expected number of flyable days per day.

Aircraft Utilization - Fleet Utilization per Flyable Day. This represents the optimum planned average flight hour task per assigned A-1/A-4 status aircraft per flyable day. It is in fact the planned operational utilization as affected by the availability factor. This is the total productivity for an assigned aircraft.

Aircraft Utilization - Operational Utilization per Flyable Day. This represents the optimum planned average flight hour task per incommission aircraft per flyable day. This is the determined productivity of an "available" aircraft.

Algorithm. A constructive calculating process that leads to a solution of a certain type of problem in a finite number of steps.

Arc. See Network.

Attrite. A student who fails and/or is released from a course of instruction in which enrolled at any time prior to successful completion of the course is considered an attrite. There are specific instructions relating to the causes of attrition.

Available Effective Instructor. An instructor is considered available if he is able to be scheduled to be flown (whether he actually flies or not). Obviously if on leave, sick, TAD, courts or boards, an instructor is not available or is not available for a normal scheduling period. If, for instance, he is available only 1/2 day, he is considered to be 50% available for that day.

Awaiting Induction Student. Awaiting induction status is defined as onboard the Wing/Station but not started into training. Awaiting induction past a normal induction date is in a "Pool" status.

Effective Instructor. An effective instructor is an aviator in a squadron who is listed as primary duty Flight Instructor and who has been NATOPS qualified, trained and standardized, and considered to be qualified to carry a student load. Once an IUT is scheduled to fly any student for any part of the prescribed syllabus he is considered "effective" even though he might have more of the IUT syllabus in which to be standardized. Primary duty and authorized admin aviators, e.g., CO, XO, Training Officer, etc., even though they may be qualified to carry a student load, shall not be reported as effective instructors.

Final Completion. A student is considered a final completion when he has successfully completed the entire prescribed stages and phases of a syllabus leading to designation and is counted against the prescribed PTR/NFOTR.

Instructor Availability. This is the determined average percent of the time that a "PIT" instructor pilot (IP) is available to fly. Unavailability allows for leave, sickness, admin overhead, etc. It is a critical factor in determining the optimum planned flight hour task for squadron aviators.

Instructor Hours per Student. The determined average total instructor flight hours required to complete a student including extra time. Times spent on attrited students and all other ancillary time are prorated against the successful graduate.

Instructor Overhead Hours per Day. This factor enters into the determination of the "turn-around-time" for instructors and relates to the determined daily average administrative time lost between flights over and above student contact time, schedule delay time and pure unavailability. Overhead time covers such

things as musters, inspections, change of duty sections. It amounts to about 20 to 50 minutes per scheduled flyable day.

Instructor Student Contact Time per Sortie Hour. The contact time here is in addition to the syllabus flight time. It is the student-instructor involvement factor. It highlights the fact that an effective instructor is employed to a much greater extent than just the indicated flight hours per flyable day.

Instructor Utilization per Flyable Day. The optimum planned average total flight hours (to two decimal places) per available effective instructor per flyable day. Peacetime factors are based on an 8-hour day and surge factors on a 10-hour day.

Instructor Utilization per Year. The annual average total flight hours per instructor (hours per flyable day times expected flyable days for the year).

In-Transit Student. An in-transit student is one who has been transferred from a particular Phase, Squadron or Wing and ordered to report to a different Phase, Squadron or Wing and not yet picked up by his new activity.

Mathematical Model. The general characterization of a process, object or concept, in terms of mathematics, which enables the relatively simple manipulation of variables to be accomplished in order to determine how the process, object or concept would behave in different situations.

Network. A configuration of nodes and arcs where the nodes are analygous to the interchanges in the interstate highway system and the arcs are the one-way segments of the interstate system connecting the interchanges. For our purposes, an arc (x,y) is completely defined as originating at node x and terminating at node y. Nodes are variously called vertices, junction points or points. Arcs are referred to as links, branches or edges. We use the node-arc terminology throughout.

NFOTR. "Naval Flight Officer Training Rate" - Same type of breakdown as PTR and by pipeline - RIO, BJN, NAV, AEW/AELW/ATDS, etc.

Node. See Network.

"Non- Pipeline" Students Special or Refresher students not preceding through any of the entire prescribed pipeline syllabi and not chargeable to the published designation training rate are considered as "Non-Pipeline."

Non- Standard "Pipeline" Student. Foreign or Coast Guard student in one of the "Pipelines", chargeable to the established annual training rate and receiving an approved syllabus.

Phase. A phase of training is a major portion of the prescribed steps through a pipeline. For example, in the pilot training syllabus, Primary, Basic and Advanced are phases.

Phase Completion. A student shall be reported as a completion when he has successfully completed the prescribed syllabus for the reported phase of training and has been transferred to a subsequent phase.

"Pipeline" Students. A student (Pilot or NFO) who is in the training system and chargeable/credited to the prescribed training rate for the year.

PTR. "Pilot Training Rate" - The CNO approved and published Pilot Training Program Output Goals for a given fiscal year. This PTR not only establishes the gross, or total rate but also the breakdown by Navy/Marine/Coast Guard/ Foreign and by pipeline - Jet/Prop/Helo.

Scheduled Day. A scheduled day is a day during which normal flight operations are scheduled in each particular reported squadron. A scheduled day therefore excludes days or fractions of days during which there is a cessation of normal schedule operations such as most weekends, holidays, safety stand-downs, admin inspections, change-of-command, etc. Normal might be defined as a situation during which the majority of students, instructors and aircraft are scheduled to perform training or training-related missions. If half a normal day is scheduled, it would be considered a 0.5 scheduled day. When only a few cross-country, test or IUT flights are scheduled over a weekend, the Saturday in question is not considered a scheduled day. The standard number of scheduled days are dependent upon whether the planning factors in use are peacetime factors (5-day week/50-week year) for 243 days; surge factors (5.5-day week/50-week year) for 268 days; or mobilization (6-day week/52-week year) for 353 days.

Sortie Length. An overall recorded average length of all flights.

Stage. A stage of training is an internal and integral segment of a training phase, e.g., the Transition Stage or Basic Instrument Stage of the Basic Flight Training Phase of Training.

Standard "Pipeline" Student. A U.S. Navy or Marine student inducted, undergoing training, completed or attrited from the prescribed syllabus leading to designation as a qualified Naval Aviator or Naval Flight Officer.

Student Attrition. Expected percent of students who will not successfully complete the course for any reason (flight failure, DOR, fatalities, physical, etc.).

Student Hours to Complete. Average total student log book hours required to successfully complete the prescribed syllabus. For the average student, this will include a certain amount of incomplete and re-fly time, extra time but does not include pure ancillary time not syllabus related.

Weather - Flyable Days. "Flyable Days" and fractional parts thereof. The equation for determining "Flyable Days" is as follows:

$$\frac{(\text{Scheduled Flights} - \text{Flights Lost to WX}) \times \text{Scheduled Days}}{\text{Scheduled Flights}}$$

"Scheduled Flights" are also related to the "Scheduled Day" definition in that a "Normal" day's schedule should be the foundation stone in this consideration. A student load generates a requirement for the scheduling of many different types of flights, e.g., student syllabus flights, instructor training, NATOPS, standardization board flights; test, ferry, weather and other overhead flights. Therefore, the normal total schedule is directly related to the "available" student load. In most instances, all or most "available" students would be scheduled dependent upon their individual status. After a "Normal" schedule is roughed out, then certain flights could fall out of the schedule due to lack of aircraft or instructors, or whatever limiting factor might impact on the scheduling capability. After flights lost to aircraft, instructors and other have been deducted, the remainder should reflect the real schedule - the "Scheduled Flights: element in the equation. Then, the computation should be straightforward in determining the effect of weather on the schedule.

Weather - Percent (%). The percent of scheduled flights that can be expected to be flyable as far as the effects of weather are concerned. The following equation applies:

$$WX\% = \frac{\text{Scheduled flights} - \text{Flights lost to WX}}{\text{Scheduled Flights}} \times 100.$$

Notice that scheduled flights lost to lack of aircraft, students, instructors, etc., are not a function of the weather factor. Also, note this is not just a pure meteorological factor - the type training and mission play a role.

APPENDIX B

ABBREVIATIONS

Appendix B

ABBREVIATIONS

A	Attrition: A statistical estimate of the percentage of students entering a phase of training who will not complete the phase for any reason.
+A	This is the prephase attrition representing the percentage of expected losses in the number of phase entrants before final graduation from UPT.
A+	This is the postphase attrition representing the percentage of expected losses in the number of phase graduates before final graduation from UPT.
ADP	Automatic Data Processing.
AH	The Advanced Helo (Advanced Rotary Wing) phase of flight training.
AI	Aviation Intelligence
AMDO	Aviation Maintenance Duty Only
AOC	Aviation Officer Candidate
AOCS	Aviation Officer Candidate School
APFI	Aviation Pre-flight Indoctrination
APN	Aircraft Procurement, Navy -- an appropriation term of reference
AS	The Advanced Strike phase of flight training.
ASR	Aviation Statistical Report -- a monthly UPT report.
AVROC	Aviation Reserve Officer Candidate.
B	A parameter used in place of the phase time to train which represents a weight, bias or cost of the phase of training.
C	The maximum weekly capacity to train phase graduates in a phase of training in UPT.
C+	This is C reduced by all postphase attrition (A+) so that C is expressed in terms of pipeline graduates.
CAT I	Normally a first tour pilot entering FRS -- all UPT grads are CAT I.
CNATRA	Chief of Naval Air Training

CNET	Chief of Naval Education and Training
CNO	Chief of Naval Operations
CQ	Carrier Qualification on an aircraft carrier
CV	An aircraft carrier
CVT	An aircraft carrier with the primary mission of training
D	Work day factor (1 --> workday, 0 --> non-workday).
DSFM	Dynamic Student Flow Model
ECP	Enlisted Commission Program
FASOTRAGRU	Fleet Aviation Specialized Operational Training Group
FIT	Flight Instrument Trainer
FRS	Fleet Readiness Squadron (sometimes abbreviated further to RS)
H	Daylight hours in a particular day
ID	Identification -- a combination of alphanumerics uniquely identifying a member of a class of people or things
IP	Instructor Pilot
IP	The Intermediate Prop/Helo phase of flight training
IS	The Intermediate Strike phase of flight training
L	The average weeks required to train a student in a phase of training
LANT	Atlantic Fleet
M	The minimum weekly capacity to train phase graduates in a phase of training in UPT
MPN	Military Personnel, Navy -- an appropriation term of reference
MT	Advanced Maritime -- a syllabus version of the advanced prop training phase of training
NARM	Navy Resource Model
NATRACOM	Navy Aviation Training Command
NAVAIRLANT	Naval Air Forces, Atlantic Fleet
NAVAIRPAC	Naval Air Forces, Pacific Fleet
NFO	Naval Flight Officer

NMPC	Naval Military Personnel Command
NROTC	Naval Reserve Officer Training Candidate
OBL	Onboard Load (of students)
(OBL)+	Onboard Load reduced by postphase attrition so as to represent pipeline graduates
OFT	Operational Flight Trainer
O&I	Organizational and Intermediate Maintenance
OMN	Operations and Maintenance, Navy -- an appropriation term of reference
OpNav	The Office of the Chief of Naval Operations (his staff)
Op-59	Director, Aviation Manpower and Training Division
PAC	Pacific Fleet
PCS	Permanent Change of Station
PH	Primary Helo phase of flight training
PM	Phased Maritime phase of flight training
POL	Petroleum, Oil and Lubricants
PR	Primary phase of flight training
PTR	Pilot Training Rate (annual)
SERGRAD	Selectively Retained Graduate (from UPT)
SERE	Survival, Evasion, Resistance and Escape
SNA	Student Naval Aviator
TPOI	Time Period of Interest (normally three years)
TR	Transit -- an event in the course of UPT training when significant geographic separation is involved between phases
TRAWING	Training Wing in the UPT -- has two or more squadrons reporting to it
UPT	Undergraduate Pilot Training
USCG	United States Coast Guard
USMC	United States Marine Corps
USN	United States Navy

VAMOSC Visibility and Management of Operating and Support Costs

VTX The forthcoming jet trainer now under procurement

W Weather factor -- the expected percentage of flyable weather over a specified period of time

APPENDIX C

PATHFINDER - DYNAMIC STUDENT FLOW MODEL
BASIC UPT - FY81 WK1 - SOLUTION 8A.2G

FULL STAFF SUMMARY

05/14/81 PATHFINDER - DYNAMIC STUDENT FLOW MODEL
BASIC UPT - FY81 WK1 - SOLUTION 8A.26 075151

FULL STAFF SUMMARY

STUDENTS COMMENCING PHASE TRAINING		FY81	FY82	FY83
PRIMARY		2095	2224	2249
	FQ1	451	464	481
	FQ2	409	448	455
	FQ3	573	639	640
	FQ4	662	673	673
INTERMEDIATE STRIKE		585	649	680
	FQ1	96	135	158
	FQ2	133	143	153
	FQ3	171	185	185
	FQ4	185	186	184
ADVANCED STRIKE		577	583	597
	FQ1	133	114	126
	FQ2	131	123	123
	FQ3	143	166	168
	FQ4	170	180	180
PHASED MARITIME		422	431	446
	FQ1	76	95	106
	FQ2	95	85	89
	FQ3	121	120	121
	FQ4	130	131	130

PATHFINDER - DYNAMIC STUDENT FLOW MODEL
05/14/81 BASIC UPT - FY81 WK1 - SOLUTION 8A.26 075151

FULL STAFF SUMMARY

STUDENTS COMMENCING PHASE TRAINING		FY81	FY82	FY83
INT. PROP FOR HELO		634	683	742
	FQ1	119	142	158
	FQ2	112	127	146
	FQ3	211	213	227
	FQ4	192	201	211
PRIMARY HELO		617	670	732
	FQ1	106	139	148
	FQ2	130	129	150
	FQ3	186	204	224
	FQ4	195	198	210
ADVANCED HELO		599	665	709
	FQ1	120	144	145
	FQ2	115	134	145
	FQ3	186	196	212
	FQ4	178	191	207

PATHFINDER - DYNAMIC STUDENT FLOW MODEL

05/14/81 BASIC UPT - FY81 WK1 - SOLUTION 8A.26 075151

FULL STAFF SUMMARY

GRADUATES		FY81	FY82	FY83
STUDENTS FROM SCHOOLS COMMAND		2092	2294	2244
	FQ1	470	537	479
	FQ2	490	446	455
	FQ3	545	638	638
	FQ4	587	673	672
PRIMARY		1681	1805	1867
	FQ1	333	366	400
	FQ2	331	366	372
	FQ3	540	573	594
	FQ4	477	500	501
INTERMEDIATE STRIKE		577	595	628
	FQ1	137	113	114
	FQ2	127	123	123
	FQ3	143	174	206
	FQ4	170	185	185
ADVANCED STRIKE		562	545	567
	FQ1	121	116	118
	FQ2	118	110	129
	FQ3	186	156	157
	FQ4	137	163	163
PHASED MARITIME		396	422	437
	FQ1	77	88	88
	FQ2	81	88	88
	FQ3	122	136	151
	FQ4	116	110	110

05/14/81 PATHFINDER - DYNAMIC STUDENT FLOW MODEL
BASIC UPT - FY81 WK1 - SOLUTION 8A.28 075151

FULL STAFF SUMMARY

GRADUATES		FY81	FY82	FY83
INT. PROP FOR HELO		617	669	732
	FQ1	109	141	159
	FQ2	128	126	142
	FQ3	189	208	229
	FQ4	191	194	202
PRIMARY HELO		613	660	721
	FQ1	120	132	140
	FQ2	116	132	149
	FQ3	185	204	227
	FQ4	192	192	205
ADVANCED HELO		579	640	668
	FQ1	131	124	121
	FQ2	115	142	144
	FQ3	173	191	206
	FQ4	160	183	197

FULL STAFF SUMMARY

TRAINING CAPACITY		FY81	FY82	FY83
PRIMARY		2386	2388	2386
	FQ1	561	562	560
	FQ2	497	497	497
	FQ3	640	639	641
	FQ4	688	690	688
INTERMEDIATE STRIKE		706	706	706
	FQ1	165	165	165
	FQ2	152	152	152
	FQ3	185	185	185
	FQ4	204	204	204
ADVANCED STRIKE		627	627	627
	FQ1	146	146	146
	FQ2	134	134	134
	FQ3	167	167	167
	FQ4	180	180	180
PHASED MARITIME		455	455	455
	FQ1	106	106	106
	FQ2	98	98	98
	FQ3	120	121	122
	FQ4	131	130	129

05/14/81 PATHFINDER - DYNAMIC STUDENT FLOW MODEL
BASIC UPT - FY81 WK1 - SOLUTION 8A.28 075151

FULL STAFF SUMMARY

TRAINING CAPACITY		FY81	FY82	FY83
INT. PROP FOR HELO		762	761	762
	FQ1	160	160	162
	FQ2	148	148	146
	FQ3	226	227	227
	FQ4	228	226	227
PRIMARY HELO		681	683	733
	FQ1	138	138	148
	FQ2	140	140	150
	FQ3	207	207	225
	FQ4	196	198	210
ADVANCED HELO		674	678	725
	FQ1	148	147	158
	FQ2	137	137	148
	FQ3	195	196	212
	FQ4	194	198	207

05/14/81 PATHFINDER - DYNAMIC STUDENT FLOW MODEL
BASIC UPT - FY81 WK1 - SOLUTION 8A.26 075151

FULL STAFF SUMMARY

GRADUATE CAPACITY		FY81	FY82	FY83
PRIMARY		1868	1980	1982
	FQ1	333	400	400
	FQ2	344	389	390
	FQ3	690	691	689
	FQ4	500	499	501
INTERMEDIATE STRIKE		670	649	649
	FQ1	137	113	113
	FQ2	140	143	143
	FQ3	207	207	207
	FQ4	185	185	185
ADVANCED STRIKE		600	596	595
	FQ1	120	117	117
	FQ2	131	129	129
	FQ3	186	186	185
	FQ4	161	163	163
PHASED MARITIME		428	445	445
	FQ1	77	87	87
	FQ2	81	88	88
	FQ3	151	151	151
	FQ4	118	118	118

05/14/81 PATHFINDER - DYNAMIC STUDENT FLOW MODEL
BASIC UPT - FY81 WK1 - SOLUTION 8A.26 075151

FULL STAFF SUMMARY

GRADUATE CAPACITY		FY81	FY82	FY83
INT PROP FOR HELO		733	753	754
	FQ1	144	165	165
	FQ2	141	141	142
	FQ3	229	229	228
	FQ4	217	216	217
PRIMARY HELO		674	674	721
	FQ1	133	132	139
	FQ2	139	139	150
	FQ3	210	209	226
	FQ4	191	192	204
ADVANCED HELO		649	647	690
	FQ1	131	124	127
	FQ2	141	144	156
	FQ3	194	193	209
	FQ4	182	183	196

FULL STAFF SUMMARY

AVERAGE STUDENT ONBOARD LOAD IN TRAINING		FY81	FY82	FY83
PRIMARY		685	728	741
	FQ1	704	723	745
	FQ2	677	720	745
	FQ3	680	740	746
	FQ4	680	728	728
INTERMEDIATE STRIKE		231	248	261
	FQ1	241	244	252
	FQ2	211	249	281
	FQ3	231	254	270
	FQ4	240	244	244
ADVANCED STRIKE		209	202	210
	FQ1	224	194	215
	FQ2	227	201	212
	FQ3	194	207	207
	FQ4	194	205	205
PHASED MARITIME		165	171	178
	FQ1	152	173	183
	FQ2	163	180	193
	FQ3	177	167	171
	FQ4	165	166	166

PATHFINDER - DYNAMIC STUDENT FLOW MODEL
05/14/81 BASIC UPT - FY81 WK1 - SOLUTION 8A.26 075151

FULL STAFF SUMMARY

AVERAGE STUDENT ONBOARD LOAD IN TRAINING		FY81	FY82	FY83
INT. PROP FOR HELO		62	66	73
	FQ1	57	65	73
	FQ2	64	67	77
	FQ3	64	68	74
	FQ4	62	65	69
PRIMARY HELO		62	66	73
	FQ1	57	68	73
	FQ2	62	65	73
	FQ3	60	64	71
	FQ4	68	68	73
ADVANCED HELO		132	143	153
	FQ1	141	145	152
	FQ2	128	151	156
	FQ3	130	139	150
	FQ4	128	138	153

FULL STAFF SUMMARY

AVERAGE STUDENT ONBOARD LOAD IN POOL		FY81	FY82	FY83
INTO PRIMARY		58	67	74
	FQ1	19	46	74
	FQ2	90	74	74
	FQ3	87	74	74
	FQ4	35	74	74
INTO INTERMEDIATE STRIKE		4	15	27
	FQ1	0	8	44
	FQ2	0	7	15
	FQ3	2	1	3
	FQ4	14	44	47
INTO ADVANCED STRIKE		2	4	17
	FQ1	1	2	3
	FQ2	6	1	1
	FQ3	0	1	16
	FQ4	0	14	45
INTO PHASED MARITIME		1	2	1
	FQ1	1	2	2
	FQ2	3	3	2
	FQ3	1	0	0
	FQ4	0	2	1

FULL STAFF SUMMARY

AVERAGE STUDENT ONBOARD LOAD IN POOL		FY81	FY82	FY83
INTO INT. PROP FOR HELO		2	3	4
	FQ1	2	3	10
	FQ2	5	2	3
	FQ3	2	0	0
	FQ4	1	6	5
INTO PRIMARY HELO		3	3	6
	FQ1	2	3	6
	FQ2	2	2	4
	FQ3	1	1	7
	FQ4	6	7	8
INTO ADVANCED HELO		5	8	13
	FQ1	4	10	5
	FQ2	1	4	8
	FQ3	2	6	18
	FQ4	11	11	21
TOTAL CNATRA		92	120	160
	FQ1	43	90	160
	FQ2	121	107	121
	FQ3	116	104	138
	FQ4	87	177	220

PATHFINDER - DYNAMIC STUDENT FLOW MODEL
05/14/81 BASIC UPT - FY81 WK1 - SOLUTION 8A.28 075151

FULL STAFF SUMMARY

NOMINAL ONBOARD LOAD		FY81	FY82	FY83
PRIMARY		780	794	794
	FQ1	766	805	806
	FQ2	840	861	860
	FQ3	784	784	784
	FQ4	733	733	733
INTERMEDIATE STRIKE		274	272	272
	FQ1	291	276	276
	FQ2	290	296	296
	FQ3	270	270	270
	FQ4	250	249	249
ADVANCED STRIKE		224	221	221
	FQ1	238	223	222
	FQ2	237	240	240
	FQ3	219	219	219
	FQ4	205	205	205
PHASE MARITIME		180	181	181
	FQ1	179	183	183
	FQ2	194	197	198
	FQ3	180	180	180
	FQ4	166	166	166

FULL STAFF SUMMARY

NOMINAL ONBOARD LOAD		FY81	FY82	FY83
INT. PROP FOR HELO		75	75	75
	FQ1	74	74	75
	FQ2	77	77	77
	FQ3	74	74	74
	FQ4	75	75	75
PRIMARY HELO		68	68	73
	FQ1	71	68	73
	FQ2	69	69	74
	FQ3	66	66	72
	FQ4	68	68	73
ADVANCED HELO		149	146	156
	FQ1	159	146	155
	FQ2	155	155	167
	FQ3	140	140	151
	FQ4	142	143	153

05/14/81 PATHFINDER - DYNAMIC STUDENT FLOW MODEL 075151
BASIC UPT - FY81 MK1 - SOLUTION 8A.28

FULL STAFF SUMMARY

TOTAL STUDENT-WEEKS IN POOLS

		FY81	FY82	FY83
INTO PRIMARY		2926	3382	3701
	FQ1	235	560	888
	FQ2	1084	897	888
	FQ3	1142	962	963
	FQ4	465	963	962
INTO INTERMEDIATE STRIKE		221	787	1388
	FQ1	0	102	539
	FQ2	5	89	181
	FQ3	28	23	48
	FQ4	188	573	620
INTO ADVANCED STRIKE		121	245	860
	FQ1	21	26	37
	FQ2	82	14	16
	FQ3	8	21	219
	FQ4	10	184	588
INTO PHASED MARITIME		73	108	75
	FQ1	14	27	26
	FQ2	39	43	35
	FQ3	20	2	0
	FQ4	0	36	14

05/14/81 PATHFINDER - DYNAMIC STUDENT FLOW MODEL
BASIC UPT - FY81 WK1 - SOLUTION 8A.26 075151

FULL STAFF SUMMARY

TOTAL STUDENT-WEEKS IN POOLS

		FY81	FY82	FY83
INTO INT. PROP FOR HELO		147	163	240
	FQ1	28	38	123
	FQ2	64	26	40
	FQ3	38	12	7
	FQ4	17	87	70
INTO PRIMARY HELO		151	174	344
	FQ1	26	38	78
	FQ2	27	24	57
	FQ3	16	19	99
	FQ4	82	93	110
INTO ADVANCED HELO		262	424	682
	FQ1	57	130	67
	FQ2	14	56	98
	FQ3	38	87	235
	FQ4	153	151	282
TOTAL CNATRA		3901	5283	7290
	FQ1	381	921	1758
	FQ2	1315	1149	1315
	FQ3	1290	1126	1571
	FQ4	915	2087	2646

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BASIC UPT - FY81 WK1 - SOLUTION 8A.26

FULL STAFF SUMMARY

STUDENTS IN TRAINING AT END OF PERIOD

		FY81	FY82	FY83
PRIMARY		730	772	772
	FQ1	705	742	766
	FQ2	705	745	767
	FQ3	643	705	706
	FQ4	730	772	772
INTERMEDIATE STRIKE		236	238	236
	FQ1	223	247	271
	FQ2	220	255	287
	FQ3	236	252	251
	FQ4	236	238	236
ADVANCED STRIKE		207	216	216
	FQ1	227	199	217
	FQ2	232	205	204
	FQ3	182	207	207
	FQ4	207	216	216
PHASED MARITIME		178	178	178
	FQ1	157	183	194
	FQ2	169	177	192
	FQ3	166	159	160
	FQ4	178	178	178

05/14/81 PATHFINDER - DYNAMIC STUDENT FLOW MODEL 075151
BASIC OPT - FY81 WK1 - SOLUTION 8A.26

FULL STAFF SUMMARY

STUDENTS IN TRAINING AT END OF PERIOD		FY81	FY82	FY83
INT. PROP FOR HELO		71	78	81
	FQ1	69	71	76
	FQ2	52	70	78
	FQ3	72	73	74
	FQ4	71	78	81
PRIMARY HELO		68	72	75
	FQ1	55	74	78
	FQ2	68	70	78
	FQ3	67	67	72
	FQ4	68	72	75
ADVANCED HELO		141	140	153
	FQ1	129	155	158
	FQ2	124	142	153
	FQ3	130	139	151
	FQ4	141	140	153
CNATRA TOTAL		1631	1694	1711
	FQ1	1565	1671	1760
	FQ2	1570	1664	1759
	FQ3	1496	1602	1621
	FQ4	1631	1694	1711

PATHFINDER - DYNAMIC STUDENT FLOW MODEL
05/14/81 BASIC UPT - FY81 WK1 - SOLUTION 8A.26 075151

FULL STAFF SUMMARY

POOLS AT THE END OF YEAR/QUARTER		FY81	FY82	FY83
INTO PRIMARY		1	74	74
	FQ1	21	74	74
	FQ2	101	74	74
	FQ3	75	74	74
	FQ4	1	74	74
INTO INTERMEDIATE STRIKE		25	55	58
	FQ1	0	11	34
	FQ2	2	13	13
	FQ3	0	0	6
	FQ4	25	55	58
INTO ADVANCED STRIKE		0	12	43
	FQ1	4	0	0
	FQ2	0	0	0
	FQ3	0	7	38
	FQ4	0	12	43
INTO PHASED MARITIME		0	5	2
	FQ1	0	0	1
	FQ2	8	8	9
	FQ3	0	0	0
	FQ4	0	5	2

PATHFINDER - DYNAMIC STUDENT FLOW MODEL
05/14/81 BASIC UPT - FY81 WK1 - SOLUTION 8A.28 075151

FULL STAFF SUMMARY

POOLS AT THE END OF YEAR/QUARTER		FY81	FY82	FY83
INTO INT. PROP FOR HELO		0	6	3
	FQ1	8	0	3
	FQ2	0	0	0
	FQ3	0	4	3
	FQ4	0	6	3
INTO PRIMARY HELO		0	0	0
	FQ1	3	3	11
	FQ2	0	0	4
	FQ3	4	3	8
	FQ4	0	0	0
INTO ADVANCED HELO		13	9	21
	FQ1	0	2	3
	FQ2	0	0	7
	FQ3	0	8	22
	FQ4	13	9	21
TOTAL CNATRA		39	161	201
	FQ1	36	90	126
	FQ2	111	95	107
	FQ3	79	96	151
	FQ4	39	161	201

POOLS AT START TIME: FY80 WEEK 01

INTO PRIMARY	0	0	0
INTO INTERMEDIATE STRIKE	0	0	0
INTO ADVANCED STRIKE	0	0	0
INTO PHASED MARITIME	0	0	0
INTO INT. PROP FOR HELO	0	0	0
INTO PRIMARY HELO	0	0	0
INTO ADVANCED HELO	0	0	0
TOTAL CNATRA	0	0	0

FULL STAFF SUMMARY

STUDENTS IN TRANSIT AT END OF YEAR/QUART		FY81	FY82	FY83
TO INTERMEDIATE STRIKE		0	1	0
	FQ1	17	6	4
	FQ2	13	14	14
	FQ3	49	76	78
	FQ4	0	1	0
TO PHASED MARITIME		14	14	17
	FQ1	16	17	17
	FQ2	9	9	8
	FQ3	20	21	20
	FQ4	14	14	17
TO INT. PROP FOR HELO		0	0	0
	FQ1	0	0	0
	FQ2	0	0	0
	FQ3	0	0	0
	FQ4	0	0	0
CNATRA TOTAL IN TRANSIT		14	15	17
	FQ1	33	23	21
	FQ2	22	23	22
	FQ3	69	97	98
	FQ4	14	15	17

PATHFINDER - DYNAMIC STUDENT FLOW MODEL
05/14/81 BASIC UPT - FY81 WK1 - SOLUTION 8A.28 075151

FULL STAFF SUMMARY

CNATRA TOTAL ON BOARD AT END OF PERIOD		FY81	FY82	FY83
INTRAINING/TRANSIT/POOL		1684	1870	1929
	FQ1	1634	1784	1907
	FQ2	1703	1782	1888
	FQ3	1644	1795	1870
	FQ4	1684	1870	1929

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